POWER TOPICS CROSS-INDEX

STEAM GENERATION
POWER GENERATION
WATER POWER
DIESEL & GAS ENGINES
AIR CONDITIONING & HEATING
REFRIGERATION
PUMPS & COMPRESSORS
STEAM SERVICES
ELECTRICITY & ELEVATORS
INSTRUMENTS & CONTROL
PIPING SYSTEMS
MECHANICAL TRANSMISSION
POWER MISCELLANY

VOLUME 83 NUMBER 2

# POWER

N. O. WYNKOOP, *Publisher*
PHILIP W. SWAIN, *Editor*

*Associate Editors*
F. A. ANNETT
S. A. TUCKER

E. J. TANGERMAN, *Consulting Editor*

*Assistant Editors*
B. E. SAWYER
L. N. ROWLEY

PAUL WOOTON, *Washington* G. C. TENNEY, *San Francisco* H. S. KNOWLTON, *Boston*

## FEBRUARY, 1939

24-page special section on fuel and ash handling ..... 49
Systems and equipment for moving solid fuel ..... 50
How to dispose of ash and refuse ..... 62
Fuels that flow—pulverized coal, gas and oil ..... 66
Turbine with two lives fits modernization program ..... 69
Motor controllers lock step—solving a problem ..... 72
How an average size plant has kept pace with the times ..... 74
Step-by-step procedure for taking boilers off the line ..... 76
Casey Jones rides a new steam-electric locomotive ..... 77
Photopage on Pickwick Landing hydroelectric plant ..... 80
New chemical promises sure death for slime and algae ..... 81
Operating experience with 1250-lb, 950-F top at Essex ..... 82
Gunpowder piledriver—first use of the diesel idea? ..... 85
Putting the heat on valve materials yields more data ..... 86
Hinged anchorage makes exhaust pipe follow turbine ..... 88
Europe turns to gas producers—survey of developments ..... 90
Work is cheaper than relief according to Sheboygan ..... 93
Accessibility in the boiler house—how to achieve it ..... 94
Data Sheet No. 78—Dictionary of Lubrication-I ..... 112

DEPARTMENTS

Readers Problems ..... 96
New Plant Construction ..... 100
Current Comment ..... 108
George Edwards ..... 120
Power Lines ..... 98
Practical Aids ..... 102
New Plant Equipment ..... 114
Engineers' Bookshelf ..... 122

Publication office: 99–129 North Broadway, Albany, N. Y.
Editorial & Executive Offices: 330 West 42nd St., New York, N. Y.

A McGRAW-HILL PUBLICATION

JAMES H. MCGRAW, Founder and Honorary Chairman

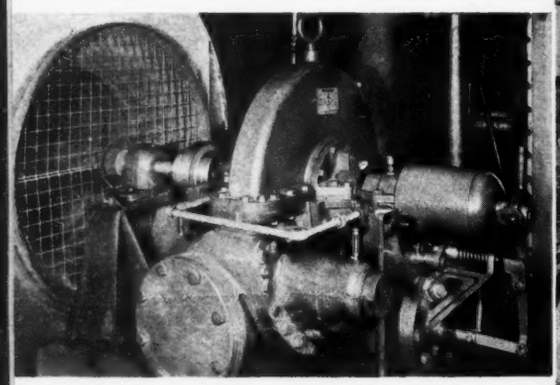
JAMES H. MCGRAW, JR., President
HOWARD EHRLICH, Executive Vice-President
MASON BRITTON, Vice-Chairman
B. R. PUTNAM, Treasurer
D. C. MCGRAW, Secretary
J. E. BLACKBURN, JR., Circulation Manager

CHICAGO, 520 North Michigan Ave.
SAN FRANCISCO, 883 Mission St.
WASHINGTON, National Press Bldg.
PHILADELPHIA, 16 South Broad St.
CLEVELAND, 1510 Hanna Bldg.
DETROIT, 2-144 General Motors Bldg.
ST. LOUIS, 455 Paul Brown Bldg.
BOSTON, 1427 Statler Bldg.
ATLANTA, 1105 Rhodes Haverty Bldg.
LONDON, Aldwych House, Aldwych, London, W C.2

POWER articles are currently indexed in both the Industrial Arts and the Engineering Indexes, available at public libraries. Also every year POWER issues an annual index of its own. Cable Address: "McGraw-Hill, N. Y."

Copyright, 1939, by McGraw-Hill Publishing Company, Inc.

# How to Buy TURBINE



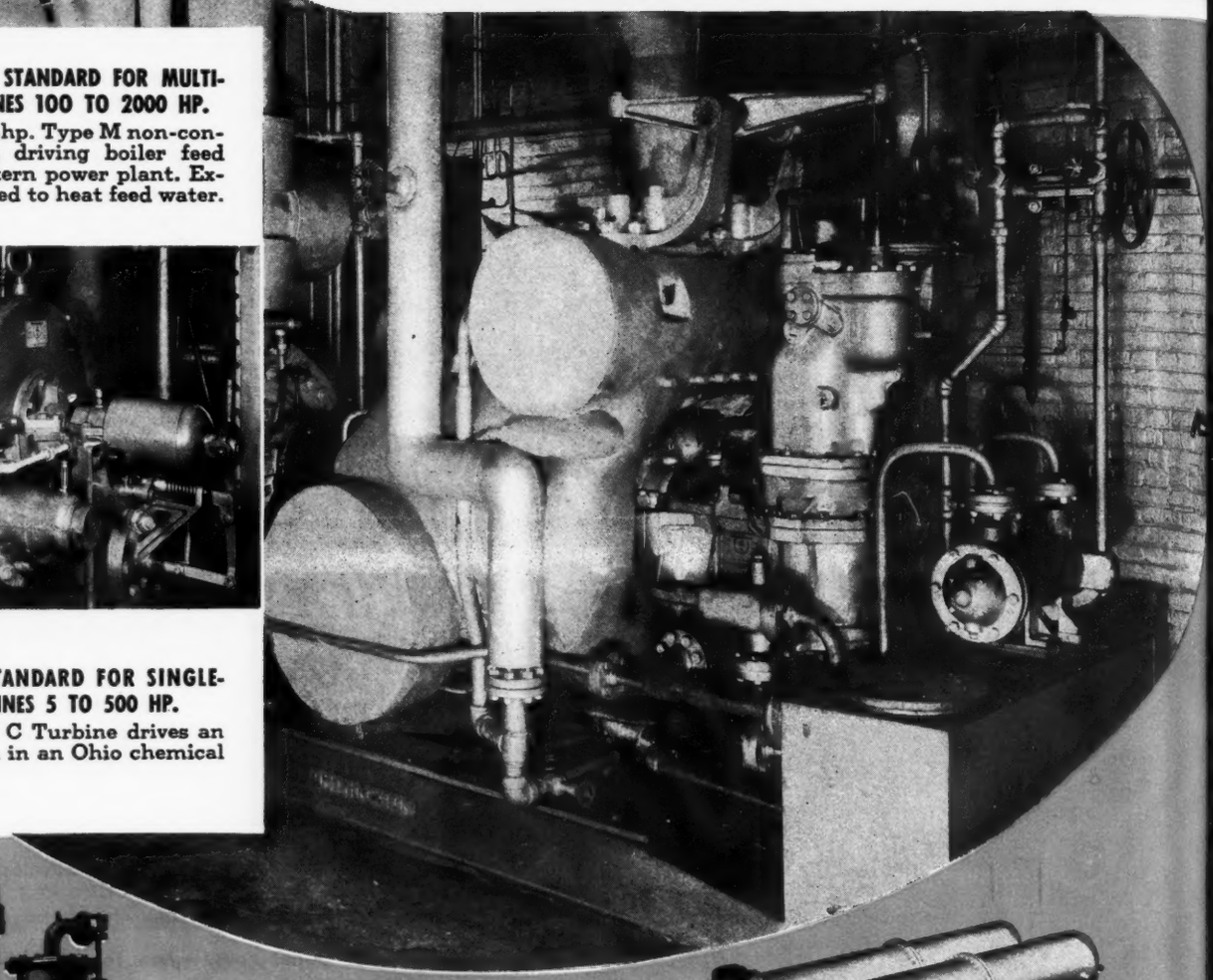
→ **TYPE M—THE STANDARD FOR MULTI-STAGE TURBINES 100 TO 2000 HP.**

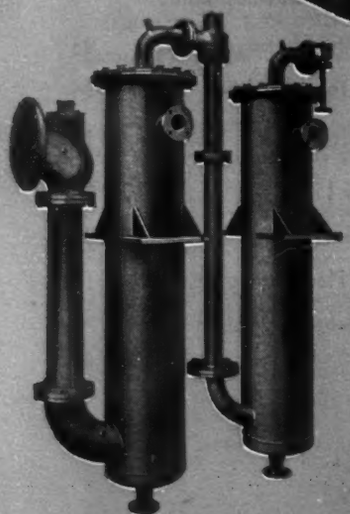
One of three 1100-hp. Type M non-condensing turbines driving boiler feed pumps in an eastern power plant. Exhaust steam is used to heat feed water.



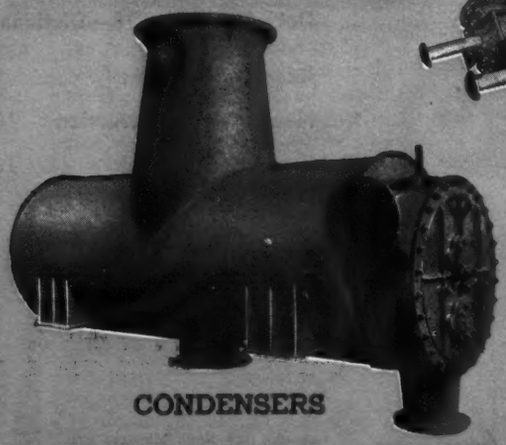
↑ **TYPE C—THE STANDARD FOR SINGLE-STAGE TURBINES 5 TO 500 HP.**

This 94-hp. Type C Turbine drives an induced draft fan in an Ohio chemical plant.

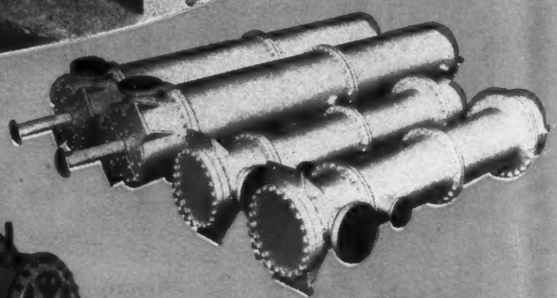




AIR EJECTORS



CONDENSERS



**FEED WATER HEATERS**

**COMPLETE LINE OF AUXILIARY EQUIPMENT**

The Westinghouse complete steam service includes apparatus for economical utilization of steam in your plant, and for maintaining the "heat balance" that means maximum value from fuel.

# Westinghouse *Complete*

POWER

Established 1882 PHILIP W SWAIN, Editor

# FUEL AND ASH HANDLING

► ASK THE AVERAGE American householder how much coal he uses in a year and he will tell you five or ten tons—or perhaps fifteen, if his house is large or the climate cold. Whatever his answer, it will be wrong, because he will forget that coal bills, like taxes, can be invisible. It would be hard to make him believe that he will buy eight tons of steam-plant coal at the mine this year, that he will hire rail or water shippers to deliver it to some factory coal pile and then pay the total cost of moving the eight tons from coal pile to the furnaces of power boilers. Yet he will certainly do just that, and pay for it, under the impression that he is buying a suit of clothes, an automobile or a loaf of bread.

To put this story another way, America's power boilers generate about one and a half billion tons of steam every year for power, process and heating. That means that an average family of five persons "consumes" sixty tons of industrial and utility steam, and necessarily consumes also the eight tons of coal required to produce this steam. Since the citizen pays for every step in getting these eight tons from mine to power boiler, he profits directly when the job is efficiently done.

Let's consider here the last step—moving the coal from yard, dock or siding to the furnace. Once it was work for shovel and wheelbarrow—work costly in dollars and in human sweat. Today most of this handling job has been taken over by motor-driven mechanical equipment, and that fact is one of the many reasons why we live better today than we did fifty years ago.

Strange to say, this beneficient revolution did not spring from humanitarian sentiments. It was the direct result of manufacturers' fighting to make a living, and a profit if possible, in a competitive world where waste meant business suicide. Yet it is comforting to some that, in this case at least, good business was also good citizenship—that every reduction in coal-handling waste has been a direct contribution to the national wellbeing, reflected immediately in more food and better clothes for the consumer—that is, for everybody.

Under present-day conditions practically all plants —however small—will find mechanical-handling equipment a paying investment. The only practical question to be answered in each case is "what equipment?"

To assist the reader in this selection, we here present a twenty-page handbook on Fuel and Ash Handling, twenty-third in POWER's series of special sections. Like its predecessors, this section is wholly practical in purpose, based on the latest information and concise enough to be read and used by the busy engineer.

Coal-handling equipment discussed and pictured includes portable conveyors, monorails, screw conveyors, bucket elevators, skip hoists, belt conveyors, Redler conveyors, apron and other types of feeder conveyors, car dumpers, car pullers. Coal weighing is covered as a natural and important part of the handling process.

Ash-handling methods shown include those applicable to coal and such special arrangements as steam, hydraulic and pneumatic systems. Practical information on bunkers and silos, and on the handling of oil, gas and pulverized fuel, rounds out the section.

Excepting only water and steam, fuel is handled in greater quantity than any other industrial raw material. Its dollar value is staggering—nearly a billion dollars yearly. This section shows how to pick up that billion dollars in the yard and carry it right to the furnace.

# COAL-HANDLING SYSTEMS

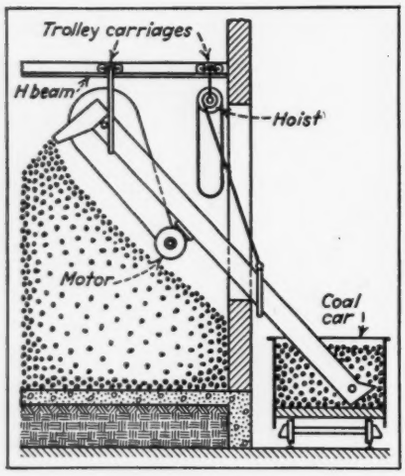
▶ MODERN COAL- AND ASH-HANDLING systems are not limited to any particular application or location. For any plant, even where only 40 to 50 tons of coal per week are used, there is equipment that is economically sound.

Today's coal-handling apparatus has many advantages over the old muscular method. First and closest to management's heart, it saves money. It eliminates dust and dirt from coal and ashes and, in many cases, the unsightly coal pile. It permits labor to give more time to using its brains, and it improves labor relations in the power plant.

Coal can be weighed automatically to each boiler. This record, in combination with steam-flow-meter readings provides a day-to-day check on boiler performance. This item alone can result in improved efficiency and fuel savings that in a short time will amount to the total cost of the coal- and ash-handling system. Modern coal-handling equipment is just as much a part of efficient plant operation as meters and automatic control. In fact, one complements the other and full benefits of either cannot be realized unless both are available.

A great many types and capacity ranges of coal- and ash-handling equipment are available. A simple, well-designed, reliable high-grade system may cost no more than a haphazard one. Kind of equipment selected is influenced by many factors, such as the size of the plant, its location, whether the system is being designed as part of a new plant or to meet the conditions in an existing one, whether coal is received by rail, truck or water; kinds of coal available, regularity of their delivery and other considerations.

Even when coal is stored on the ground outside the plant, and boilers are hand fired, most of the labor of hand-shoveling to and from storage can be eliminated by intelligent use of portable conveyors (see page 59). Fig. 1 shows how one plant uses a portable conveyor, though shoveling appears to be the normal answer to the problem. When the conveyor is not in use, its receiving end is lifted by the chain hoist and run into the storage bin out of the way.



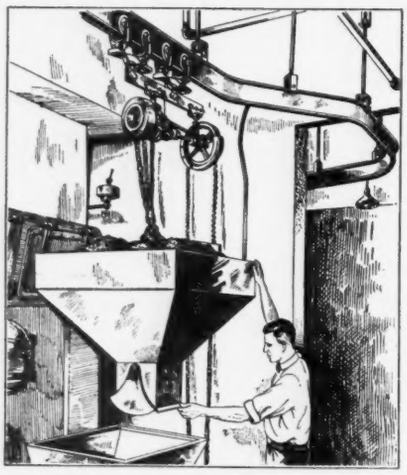



Fig. 1 (top)—Portable conveyor unloads gondola cars. Fig. 2—From bunker to stoker by monorail route

## Monorail Tramways

Plants in which stokers have been installed under old hand-fired boilers, and building power plants, frequently do not lend themselves to installation of modern coal-handling equipment. But even under the worst conditions of this kind, overhead monorail tramways, with some type of carrier (Fig. 2), have been adapted to coal and ash handling. Many such systems are in use, ranging from hand-propelled carriers, chain hoists and tip-over buckets, to systems consisting of motor-propelled carriers, electric hoists and side-dump buckets. Scales can be built into the monorail to weigh each bucket of coal, an essential to efficient power-plant operation.

Coal- and ash-handling problems involved in small- and medium-sized power plants are similar to those faced by large industrial plants and central stations. Systems for handling coal and ashes can be adapted to almost any condition, but this is no reason for assuming that they can be hung anywhere on a power plant. Consideration should be given to this problem early in the design of the plant so that there can be devised the most efficient and convenient arrangement consistent with boiler-room location, method of receiving coal, storage required, and other factors.

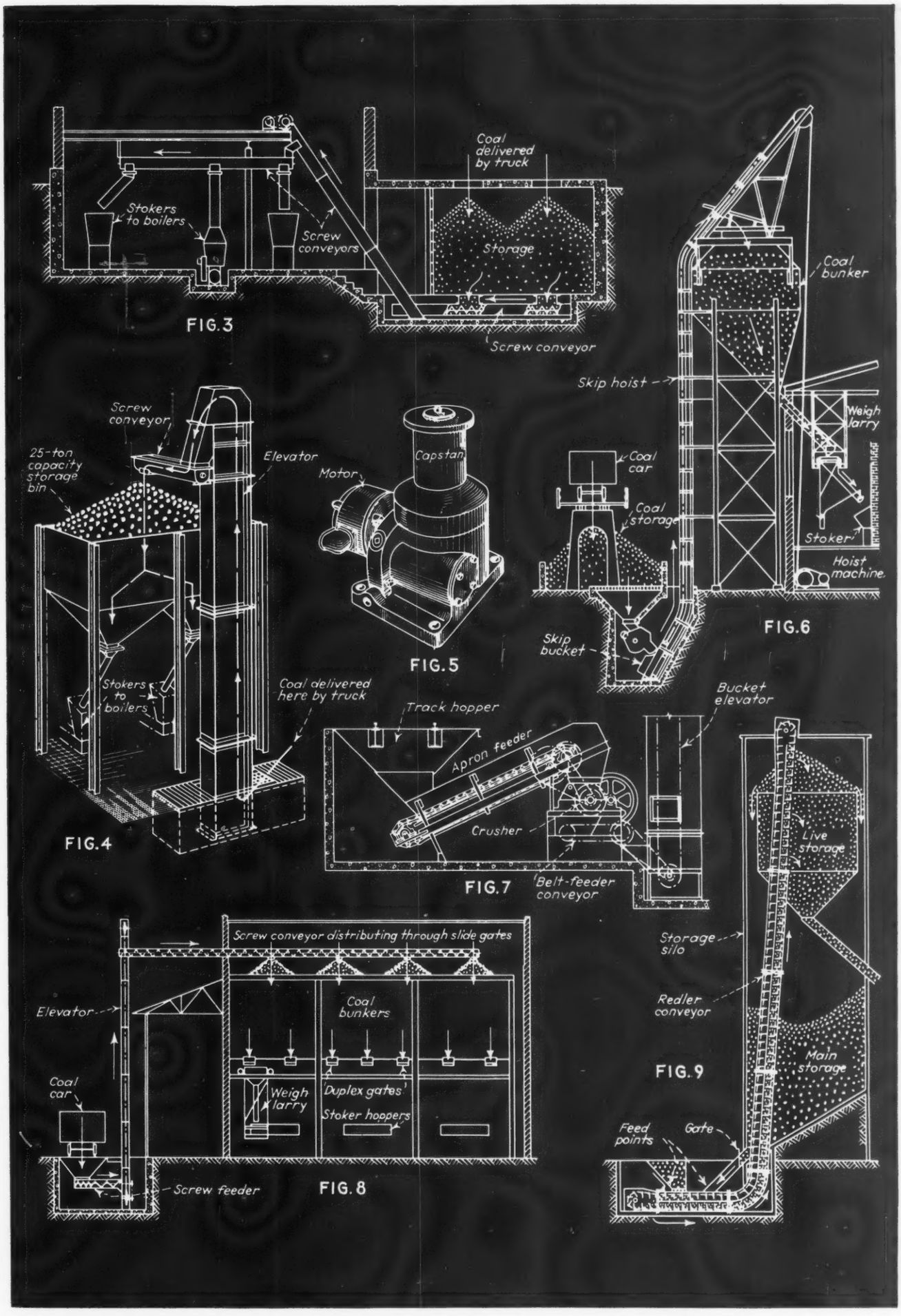
When coal is received by trucks, the problem is very simple, except for providing convenient movement of trucks. Rail and water delivery present additional problems of track space for storage of loaded and empty cars, convenient movement of cars for unloading, movement of coal from car or barge to storage, and other conditions that must be taken into account because of the limited mobility of cars and barges compared to trucks.

Coal of a size suitable for burning on stokers or for pulverizing can now be had in regular quantities, so that installation of a breaker is not generally necessary. This has simplified the coal-handling problem, particularly at small- and medium-size plants. How simple these systems can be is illustrated in Fig. 4, where coal is received by truck at a plant using 5 to 9 tons per day. The trucks dump into a receiving hopper on the boot of a bucket elevator that discharges into a screw conveyor for delivery to a 25-ton overhead bunker.

From the bunker, coal flows through spouts to the stoker hoppers. With slight variations, this equipment can be adapted to several arrangements. Frequently, the elevator can be placed to discharge directly into the bunker without the screw conveyor. It is also possible to use the elevator to handle either coal or ashes, discharging each to its respective bunker.

In Fig. 4, a weigh larry can be in-

Fig. 3—A combination of screw conveyors forms this coal-handling system. Fig. 4—Coal is received by truck, then delivered to bunker by bucket elevator and screw conveyor. Fig. 5—Motor-driven car puller. Fig. 6—Skip hoist delivers coal from track hopper to cylindrical bunker. Fig. 7—Coal is handled from track hopper by apron feeder, crusher, belt feeder and bucket elevator. Fig. 8—Screw conveyors and belt elevator comprise this coal-handling system. Fig. 9—Redler conveyor delivers coal from feeder hopper to cylindrical bunker


Coal delivered by truck
Stokers to boilers
Screw conveyors
Storage
Screw conveyor
FIG. 3
Coal bunker
Skip hoist
Weigh larry
Coal car
Coal storage
Stoker
Hoist machine
Skip bucket
FIG. 6
Screw conveyor
25-ton capacity storage bin
Elevator
Motor
Capstan
FIG. 5
Stokers to boilers
Coal delivered here by truck
FIG. 4
Track hopper
Apron feeder
Crusher
Belt-feeder conveyor
FIG. 7
Bucket elevator
Live storage
Storage silo
Redler conveyor
Main storage
FIG. 9
Screw conveyor distributing through slide gates
Elevator
Coal bunkers
Coal car
Weigh larry
Duplex gates
Stoker hoppers
Screw feeder
FIG. 8
Feed points
Gate

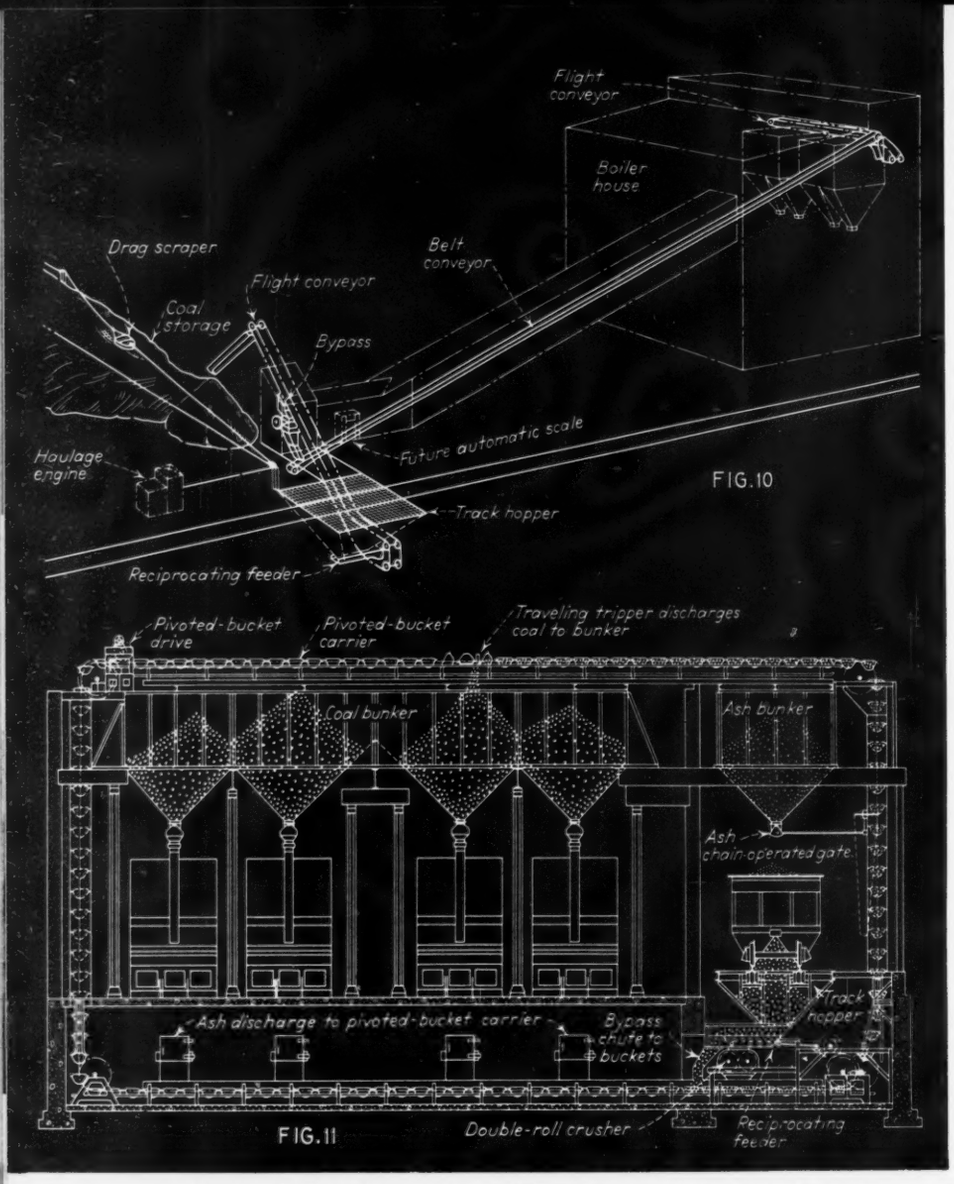



**Fig. 10—Coal handling and storage layout for a plant of 5000-kw initial capacity. Fig. 11—Pivoted bucket elevator and conveyor handles either coal or ash**

stalled to weigh the coal to each boiler, or a meter installed in each coal pipe. Overhead storage, though comparatively small, provides against interruption to delivery for 2 or 3 days. Of course, if coal supply is threatened with interruptions, it is possible to use ground storage temporarily.

Fig. 3 shows a complete system of screw conveyors applied to a small stoker-fired plant. The contour of the land around the plant permits coal to be delivered by truck to the top of the storage bin and dumped in. A horizontal section of screw conveyor takes coal from the bin and discharges to an inclined screw elevator that delivers to a horizontal run over the stoker hoppers. Gates in the bottom of the top conveyor permit discharging coal to each stoker.

In Fig. 6, coal is received on an elevated track and is normally dumped into ground storage, from where it flows through a grating into a receiving hopper. This hopper loads coal into a skip-hoist bucket that discharges into an elevated cylindrical bunker. From the bunker, coal delivery to stoker hoppers is by a weigh larry. A motor-driven capstan, Fig. 5, properly placed along the unloading track, provides the coal unloader with an easy way of moving cars and considerably reduces unloading time if several cars are to be unloaded.

Equipment in the track hopper may vary from a simple loading gate for a skip bucket, Fig. 6, to an apron or other type feed, a crusher and a magnetic belt feeder and separator discharging into an elevating conveyor, Fig. 7, depending upon conditions.

In Fig. 8, a feeder screw conveyor transfers coal from a track hopper into a bucket elevator. The elevator discharges to a screw conveyor that distributes to the different sections of the overhead bunker. For distribution in the bunker, a shuttle belt conveyor or a belt conveyor with a traveling tripper is frequently used.

Storage of coal at small- and medium-sized plants tends largely to vertical bunkers or silos. This method is compact, economical, clean, and it eliminates the open coal pile outside the plant. Arrangement may be made for live and dead storage in the same unit, Fig. 9. When the live storage section of the silo is full, any additional coal flows over the side of the live-storage bunker into the dead-storage section. A gate in the bottom of the dead-storage section permits drawing coal from the bottom of the silo directly into the elevator for return to live storage, from where it goes to stokers or pulverizers.

Fig. 10 shows equipment used at one plant for storing coal outside the plant in fairly large quantities. Coal received by rail is fed by a reciprocating feeder to an inclined flight conveyor, from which it is discharged to a belt conveyor directly or through a crusher. Or, if discharge is at the head of the flight conveyor, there forms the initial pile for the drag-scraper storage system that provides a 15,000-ton reserve.

## Bucket Carriers

In many plants, coal and ashes are handled by the same equipment, see pages 62-64. Fig. 11 shows another type of system for doing this. Here a pivoted-bucket carrier makes a complete circuit of the plant. Coal from the track hopper is fed by a reciprocating feeder directly to or through a crusher into the conveyor buckets and is dumped into the overhead bunkers by a movable tripper. When not handling coal, the carrier is available for handling ashes, which are dumped by the movable tripper into the overhead ash bunker. From there, they are discharged into railway cars.

For plants requiring large quantities of coal by rail, rapid unloading of cars is necessary. In such plants, a rotary car dumper, Fig. 1, page 60, is frequently installed. Equipment for storing and reclaiming large quantities of coal includes extensive systems of large-capacity belt conveyors, large drag scrapers with movable tail towers, aerial cableways, traveling stackers, gantry cranes, portable grab buckets and cranes.

For handling water-borne coal, some additional equipment is required for unloading the barges and boats, such as a grab bucket handled by a coal tower, or some form of a crane.

It is now generally recognized that every time coal is handled, it tends to segregate. If care is not taken in handling coal, by the time it reaches the stoker, it may vary in size and in quality over the fuel bed and for different times of the day, depending upon where it is drawn from the bunker and how it is discharged to the stoker hopper.

# SKIP HOISTS

▶ ONE OF THE MOST POPULAR pieces of coal-handling equipment is the skip hoist. It comprises a rectangular shaped bucket, Fig. 3, running on vertical or inclined steel tracks, a lifting cable with necessary sheaves, and a winding-drum mechanism connected to a suitably-controlled motor. Since the bucket is the only part of the equipment coming in contact with the material handled, the skip hoist is suitable for handling either ashes or coal, and is frequently used for both services (Fig. 7, page 63).

The bucket is usually loaded in a pit below a hopper into which the coal has been delivered from truck or railway car, Fig. 3. After the bucket is loaded, it is hoisted to the top of the bunker, and dumped. If the bunker is of the cylindrical type, as in the figure, it is generally equipped with a hinged cover that is lifted open by the bucket as it ascends to empty, and is closed as the bucket descends. This cover protects the bunker contents from the weather and prevents escape of dust.

When the bucket reaches dumping position, its front wheels follow guides curved to the horizontal. The rear-wheel axles, fitted with auxiliary wheels of a different diameter than the front wheels, become engaged in rear-wheel guides and continue upward to bring the bucket into dump position. A limit switch prevents accidental overtravel.

## Loading Method

Skip hoists are built for either manual loading and pushbutton control, or for full automatic operation. With the manually loaded type, the material is placed in the bucket manually or dumped in from cars. When it is loaded, the operator presses a button to start the hoist, after which the bucket ascends, dumps and returns, coming to rest in the pit ready for another load. This type is usually of small capacity operating at slow speed (40 to 100 fpm) without counterweights, and is commonly used for handling ashes.

For medium and high speeds, 100 to 150 fpm and 150 to 450 fpm respectively, skip hoists are usually either counterweighted, as in Fig. 1, or operator balanced, Fig. 2. The counterweight is made about equal to the weight of the bucket plus ½ the weight of its contents when fully loaded, so that the hoist motor need have only sufficient capacity to lift one half rated bucket load. For large capacities, balanced skip hoists with two buckets are used; one bucket ascends loaded while the other descends empty and while one is loading, the other is dumping.

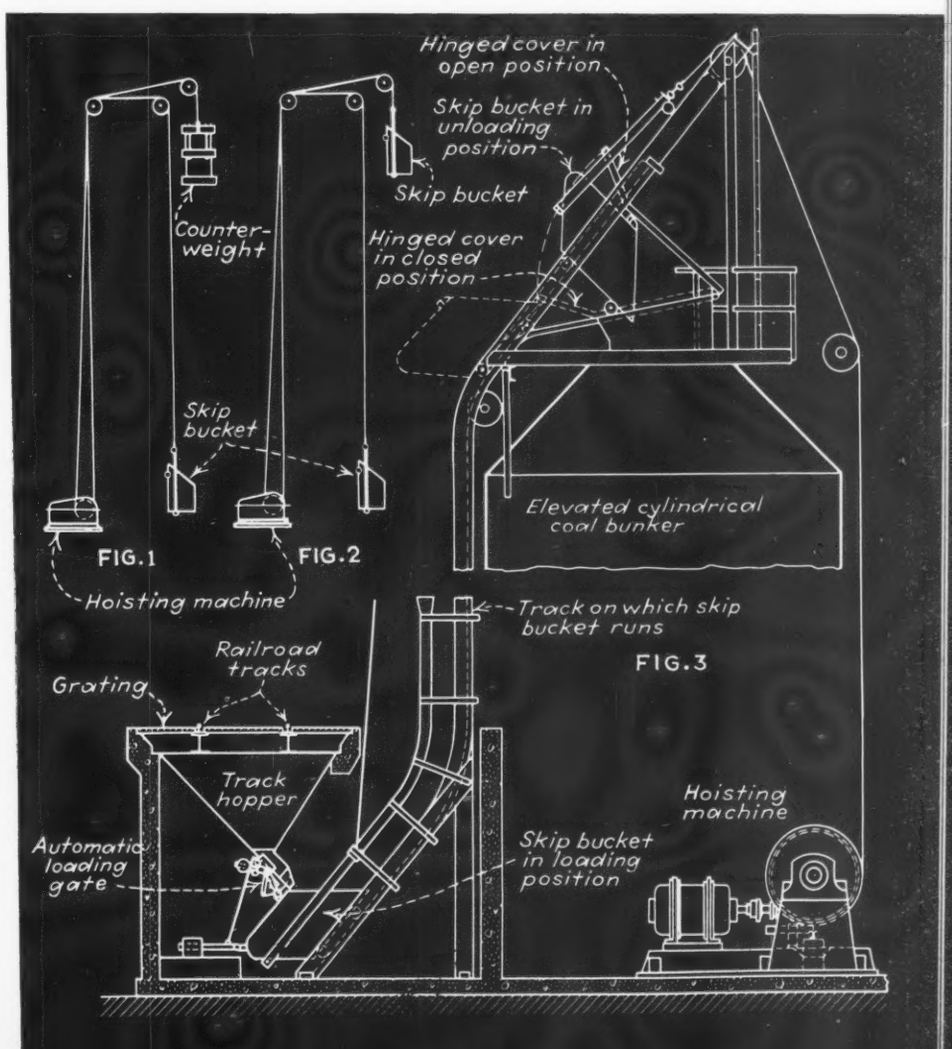
Coal-handling skip hoists are usually fully automatic, especially in medium and large capacities. When the skip bucket descends into the coal pit, it automatically turns the coal-hopper spout in position to fill the bucket. The hoist may be started by a timing relay after a predetermined time for loading has elapsed. As the bucket moves out of the pit, the loading chute moves to the closed position automatically. In another design, weight of coal in the bucket determines the time the bucket remains in the pit for loading.

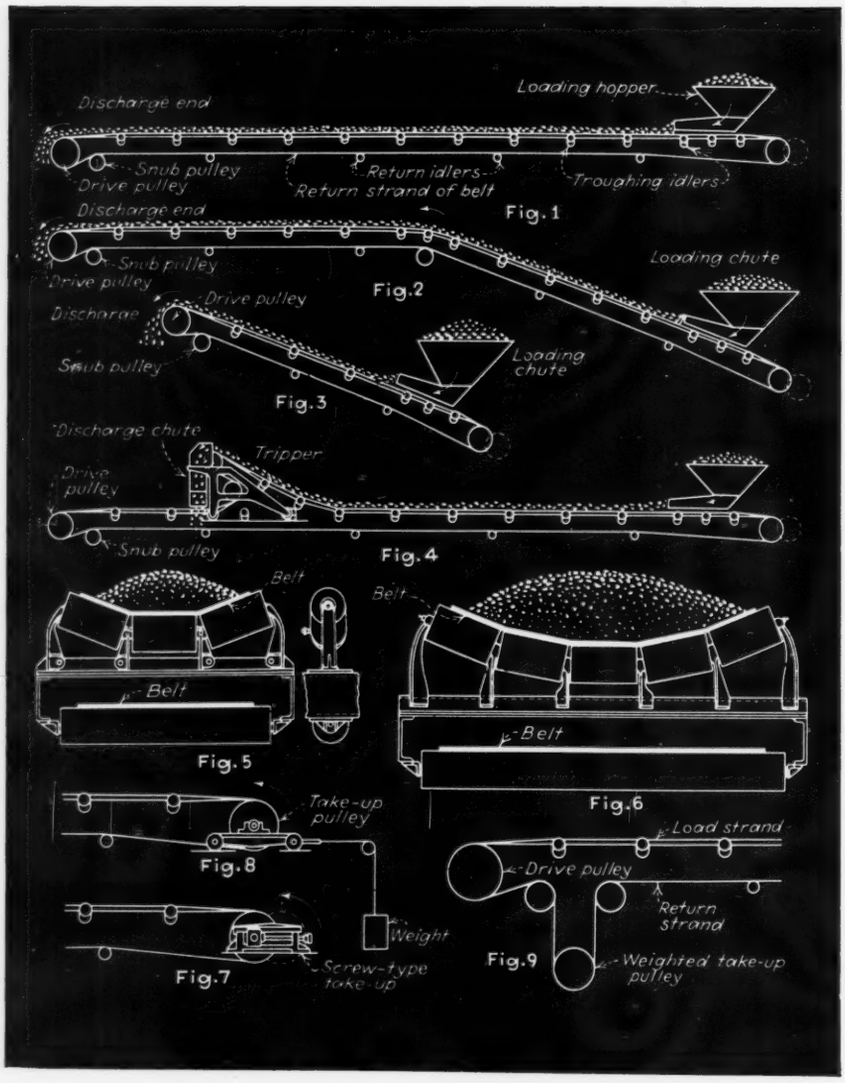
Capacity of skip hoists may range from 10 to 400 tons per hr and is governed by bucket speed, length of travel, method of loading, type of control, capacity of the skip bucket, time required for loading and whether single or balanced buckets are used.

Skip hoists most frequently discharge into a cylindrical bunker and to overhead suspended bunkers of a length that can be filled with 1, 2 or 3 spouts from a common discharge hopper. They are also used to fill long suspended bunkers when the skip discharges into a receiving hopper, from where coal is fed to a horizontal conveyor or automatic cars for distribution into the bunker.

Even though skip-hoist buckets usually operate on vertical or inclined tracks, and in one vertical plane, there are hoists on which the bucket, after being lifted to a given position, is transferred automatically to horizontal rails to discharge into any one of several storage silos.

**Fig. 1—Skip hoist with counterweight. Fig. 2—Balanced skip hoist—one bucket ascends loaded when other descends unloaded. Fig. 3—Loading and discharge mechanisms of skip hoist**






**Figs. 1 to 4—Four applications of belt conveyors. Fig. 5—Three-roller troughing idler. Fig. 6—Five-roller troughing idler. Figs. 7 to 9—Types of take-ups for belt conveyors**

# BELT CONVEYORS

▶ WHAT THE BIBLE SAID about the first being last and the last first applies to belt conveyors. The ancestry of other types of coal-handling systems dates back hundreds and, of some designs, thousands of years, but the belt conveyor can boast only a bare century. However, because of its adaptability, simplicity, efficiency, low initial cost, and wide range of sizes and capacities, it has become the most widely used design. Belt conveyors range in size from a few inches wide and a few feet long, handling a few pounds of material per hour, to 5—6 ft wide in systems several miles long, transporting many tons of material per hour.

Belt conveyors may be operated horizontally, loading at one end and discharging at the other, Fig. 1, which is the simplest type of installation. They can also be operated at an angle to the horizontal up to 30 deg, when handling coal, but the maximum recommended is 23 deg. Horizontal operation may be combined with inclined, as in Fig. 2. All three arrangements shown are for end discharge, but side discharge can be obtained by installing a movable tripper, as in Fig. 4. Many other combinations are used, but they all include the features indicated in Figs. 1 to 4.

For conveying coal, stone or similar material, troughing idlers are used for the conveying strand of the belt. These are usually of the 3-idler type, Fig. 5, or 5-idler design, Fig. 6. The latter conforms more closely to the natural trough of the belt and is used for wide belts.

The idlers, equipped with either plain-sleeve or anti-friction bearings, are assembled as a unit on steel-channel or angle bases to hold them rigidly in alignment. Because of the large power saving, anti-friction bearings are used extensively on belt conveyors. About 50% more power is required to drive a belt conveyor equipped with sleeve-bearing idlers, than one running on anti-friction-bearing idlers, other conditions being equal.

A conveyor belt must act as a carrier of material and must also transmit power. To do the latter, it must operate under a certain amount of tension, adjustment of which is accomplished by some type of take-up. Screw-type take-ups are usually at the tail pulley, which is mounted so that its bearings can be moved in guides, by two screws, as in Fig. 7, much as a motor is moved on its base. This type of take-up is used successfully, but requires occasional adjustment and slightly greater initial tension in the belt, than with automatic types, to compensate for variation in belt length.

Automatic take-ups are of two general types. With one, the tail pulley is mounted on a counterweighted movable carriage, Fig. 8. Weight of the counterweight is adjusted to maintain constant minimum necessary tension in the belt, after which this tension is maintained automatically. The gravity-type take-up consists of a weighted guided pulley suspended in a loop of the belt, Fig. 9. The pulley is weighted to give the desired initial tension on the belt.

On long belt conveyors, it may not be possible to drive from a single plain-iron or rubber-lagged-head pulley; then, a tandem or dual drive must be used. A tandem drive comprises two drive pulleys geared together, as in Fig. 10, with a motor connected to one of the gears. In a dual-motor drive, each of the two power pulleys is driven by an individual motor.

To unload a belt conveyor from the side, the case when coal is discharged into different sections of a bunker, a tripper must be installed in the carrying strand of the belt. Trippers gen-

erally are mounted on wheels to run on a rail on each side of the conveyor, as in Fig. 11, so that they can be moved. The belt passes around a head pulley and back into the tripper to pass around a secondary pulley, then continues forward between the two legs of a twin spout. Coal is discharged from the head pulley into the spout and flows down each side of the belt. Trippers are propelled along the conveyor and placed at unloading points, and are arranged to be propelled by hand, driven by the conveyor belt, or by an individual motor.

## Conveyor Belts

The belt is the most important part of the conveyor and its cost may equal that of all other parts combined. Rubber and fabric belts of special construction are used in coal handling. These belts comprise layers (plies) of 24-, 28-, 32-, 36- or 42-oz. cotton duck impregnated with a slow-aging rubber compound. The figures represent the weight of a piece of dry duck 36x42 in. in area. The duck is first impregnated with a slow-aging rubber compound, which is forced into the duck under heavy pressure between calender rolls. (This process is called frictioning). The belt is formed by folding the duck or by laying one ply of duck on another to give the desired number of plies. It is then vulcanized in a press.

Three general classes of conveyor belts are made. One is composed of uniform duck and rubber across its full width, Fig. 12. An extra heavy layer of rubber is applied to the top surface and around the edges to resist wear of the material handled. Where severe abrasion tends to wear out the belt along its center, the rubber cover is built up to extra thickness, as in Fig. 13. This belt is not suitable for tandem drives. To increase rubber thickness at the center of the belt and maintain uniform thickness across its width, a stepped-ply construction, Fig. 14, is used. This construction not only gives extra rubber where the wear is most severe, but it also permits the belt to trough more readily. Eliminating the fabric plies at the center of the belt reduces its working strength. If the belt is to transmit heavy loads, it is advisable to check with the belt manufacturer before selecting a stepped-ply belt.

## Loading Chutes

Loading-chute design is one of the most important factors in the life of the belt. The chute should be designed so that the material will be delivered to the belt in the direction of its motion and at the same speed so that there will be as little slippage as possible between material and belt. Frequently, a chute having a spaced-bar bottom can be used advantageously, Fig. 15. The fines in the coal drop through the bars onto the belt to protect its surface against impact of the lumps.

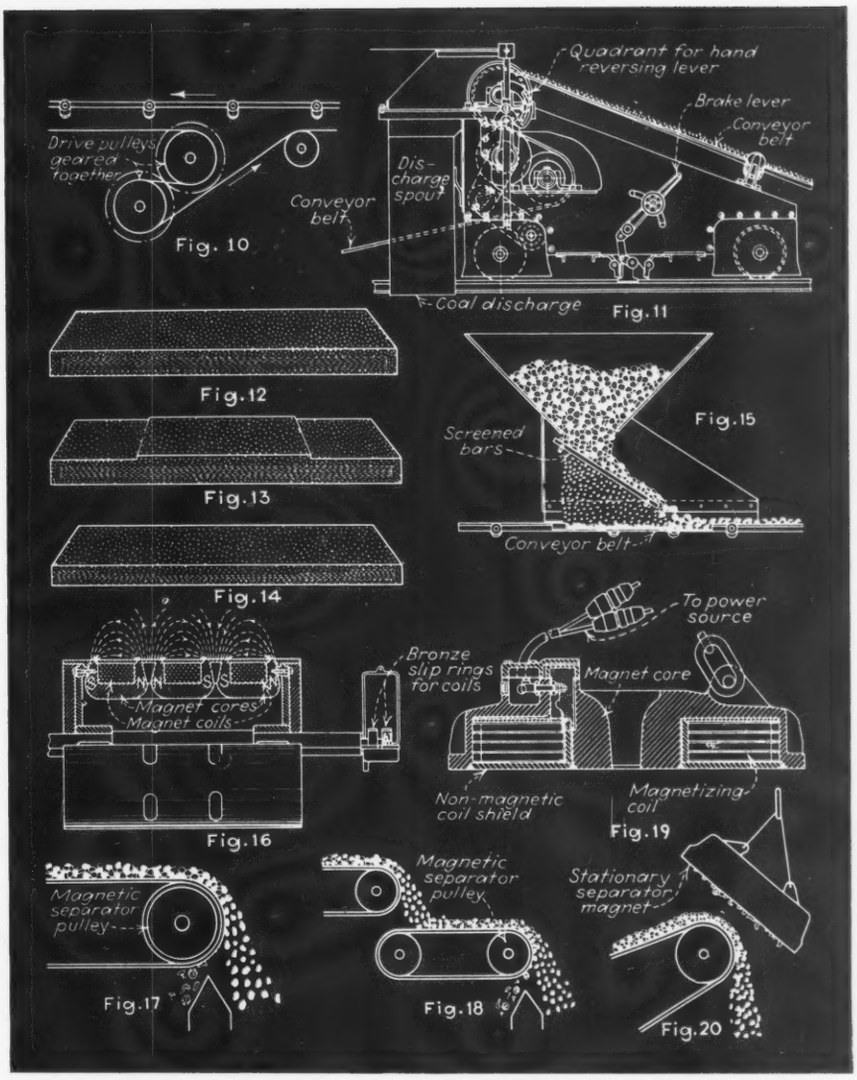



**Fig. 10—Drive-pulley arrangement for either tandem or dual drive. Fig. 11—Movable tripper for side unloading. Figs. 12 to 14—Types of belt construction used on conveyors. Fig. 15—Loading chute with bar screen for loading conveyors. Figs. 16 to 20—Magnetic-separator constructions and applications**

Tramp iron in the coal can be removed by a magnetic pulley or a stationary magnet to protect crushers and conveyors. The magnetic pulley is made in sections with a number of coils connected to form strong alternate *N* and *S* poles across the face of the pulley, Fig. 16. On end-discharge belt conveyors, the head pulley can be the magnetic unit, Fig. 17. Any magnetic material in the coal is held to the belt as it bends around the pulley until it drops back of a barrier, while the coal is free to discharge ahead of the barrier.

With tripper side-discharge belt conveyors and other types, a short magnetic-separator conveyor may be installed at some convenient transfer point in the coal-handling system, Fig. 18. Large stationary magnets, Fig. 19, similar to lifting magnets, are also used for this purpose. These are usually installed at the discharge end of the conveyor, Fig. 20. As the coal falls over the head pulley any magnetic material in it is freed and attracted to the magnet. Various designs of magnetic pulleys and stationary magnets are available, but those shown indicate the general principles and methods of application.

Where there is a possibility that the driving power may fail, thus permitting an inclined conveyor to run backwards and dump its load at the bottom, the conveyor should be equipped with some form of a hold-back, to prevent automatically backward motion of the conveyor. When coal is wet and the fines have a tendency to stick to the belt, a rotating brush installed under the head pulley will remove fines in the coal stream.

# FEEDER CONVEYORS

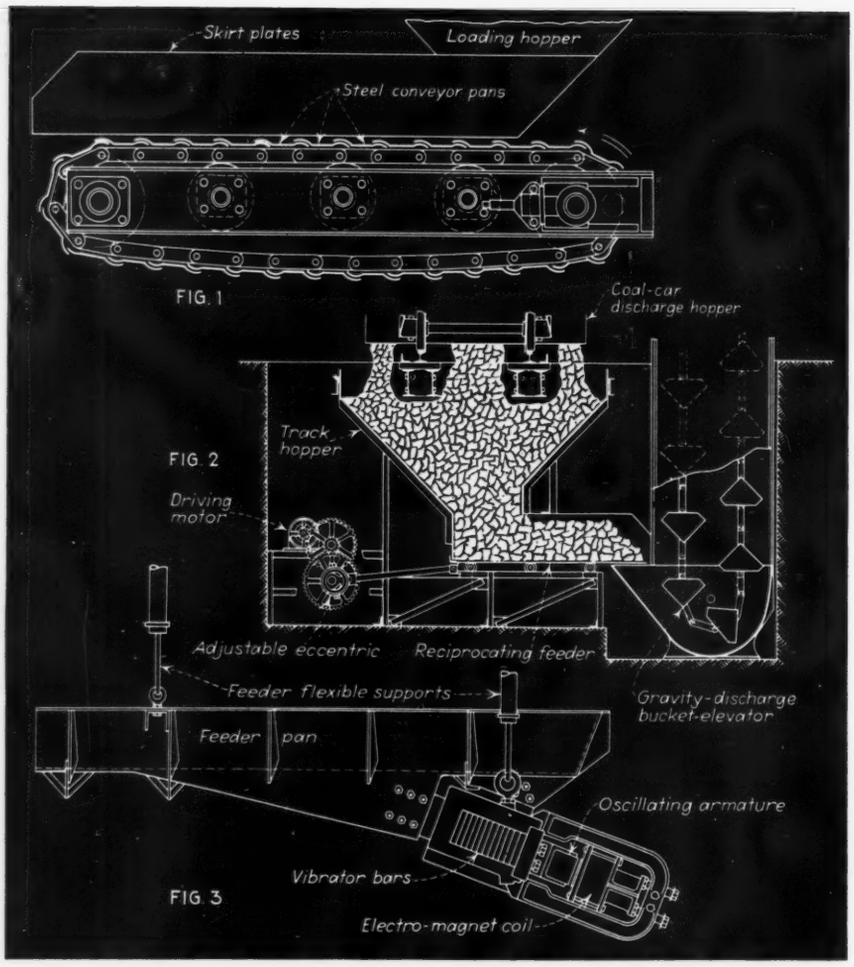



**Fig. 1 — Apron feeder. Fig. 2 — Reciprocating-pan feeder. Fig. 3 — Vibrating feeder operated by alternating-current magnet**

▶ IN PLANTS where coal is dumped from cars into a track hopper for handling by a conveyor system, it is general practice to install a feeder conveyor of some type. Such a feeder prevents flooding of conveyors and crushers, insures an even flow of coal so that the equipment operates at maximum efficiency, reduces power costs and wear and tear on equipment.

Feeder conveyors can be short-screw, apron or belt conveyors, or they can be devices designed specially for feeding applications only. Fig. 8, page 51, shows a short-screw conveyor used as a feeder to deliver coal from a track hopper to a bucket elevator.

Apron-type feeders are used extensively for handling coal. They generally comprise two strands of roller chain connected by double-beaded steel pans, Fig. 1, also Fig. 7, page 51. The usual designs of apron feeder should not be operated at more than 25 deg from the horizontal for such materials as coal and stone. When steeper inclines are necessary, steel angles are bolted to the pans to prevent the material from rolling or sliding backward. Apron feeders are usually operated at speeds of 10 to 25 fpm and are built in widths of 18 to 60 in.

Because of their large area, apron feeders permit using a large opening from track hopper to the conveyors. This combined with the tendency of the conveyor to agitate the coal in the hopper as it passes under it, is almost certain insurance against sticking in the hopper.

Belt feeders, Fig. 7, page 51, and Fig. 18, page 55, are short belt conveyors designed for feeding purposes. Principal application in handling coal is where a magnetic separator is required. The separator is installed as the head pulley of the conveyor.

Reciprocating feeders are built in several designs. The pan or plate type, Fig. 2, is most commonly used for feeding coal from track hopper or feeder chute to crusher and conveyor. This type consists of a steel plate 6 to 9 ft long by 15 to 30 in. wide, mounted on wheels running on a track, and operating between two skirt plates to guide the material. The pan is driven by one or two rods connected to an equal number of adjustable cranks or eccentrics driven by a motor. As the eccentrics revolve, they push the pan forward with its load of coal, and additional coal from the hopper falls onto the back end of the pan, to fill the space left by that carried forward by the pan, as in Fig. 2. On the return stroke, coal cannot move back with it; therefore as the pan pulls back from under the coal, it falls off the end into the elevator or crusher.

These feeders are particularly suited to a lumpy material like bituminous coal. Operating speed ranges from 10 to 30 rpm and the movement of the plate can be adjusted from zero to about 6 to 8 in. by adjusting the throw of the cranks. Volume of material handled is governed by the width between skirt plates and their depth.

### Vibrating Feeders

Vibrating feeders have been developed for a wide range of capacities. These comprise a feeding pan attached to vibrator bars, Fig. 3. A laminated armature connects to the vibrating bars and an electromagnet is anchored to the main frame. The electromagnet energized with alternating current causes the vibrator bars to deflect towards the magnet as the current builds up in the coil and to release when the current passes through zero. This action causes the bars to vibrate slightly back and forth, and with them the feeder pan, at 7200 vibrations per min on a 60-cycle circuit. These vibrations are too small to cause visible movement of the feeder pan, yet the material in the pan flows forward either uphill or down, in a smooth stream. Power required to operate these feeders is small.

Several other types of feeders are available, but those described are most commonly used for feeding coal from track hopper to crushers or conveyors.

# ELEVATOR CONVEYORS

▶ HANDLING OF COAL generally requires both horizontal and vertical movement. Most coal-handling equipment can elevate as well as convey to a certain degree, but some designs are better suited to one operation than to the other. For example, belt conveyors (pages 54 and 55) are essentially conveying machines, although they can operate up fairly steep inclines. Skip hoists (page 53) are best suited to vertical lifts or fairly steep inclines. Other designs, such as pivoted-bucket carriers, gravity-discharge elevator conveyors, Redler conveyors and other types, operate either horizontally or vertically.

A pivoted-bucket carrier, frequently used for handling either coal or ashes, Fig. 11, page 52, comprises a series of malleable cast-iron buckets, freely supported between two endless chains. By this method of suspension, the buckets are normally held in carrying position by gravity, Fig. 1. This permits a single carrier to transport material horizontally, vertically, and again horizontally, or in any desired path within a vertical plane of travel. A bucket for one type of carrier is shown in Fig. 2.

Bucket edges are curved, so that one overlaps the other, thus forming a continuous surface to prevent material from falling between the buckets when they are loaded. Loading is done on the lower run of the bucket and unloading from the top strand, as shown on page 52.

### Gravity Discharge

Gravity-discharge elevator conveyors have buckets fixed to chain links, Fig. 4, so that the former always take the position of the latter. This type of conveyor reduces breakage in handling sized coal or other friable materials. Chain speed is low, around 100 fpm, giving a gentle pick-up and discharge. Buckets can operate in either vertical or horizontal position, Fig. 3, and they discharge into a horizontal trough, after which they push the material along to the discharge point.

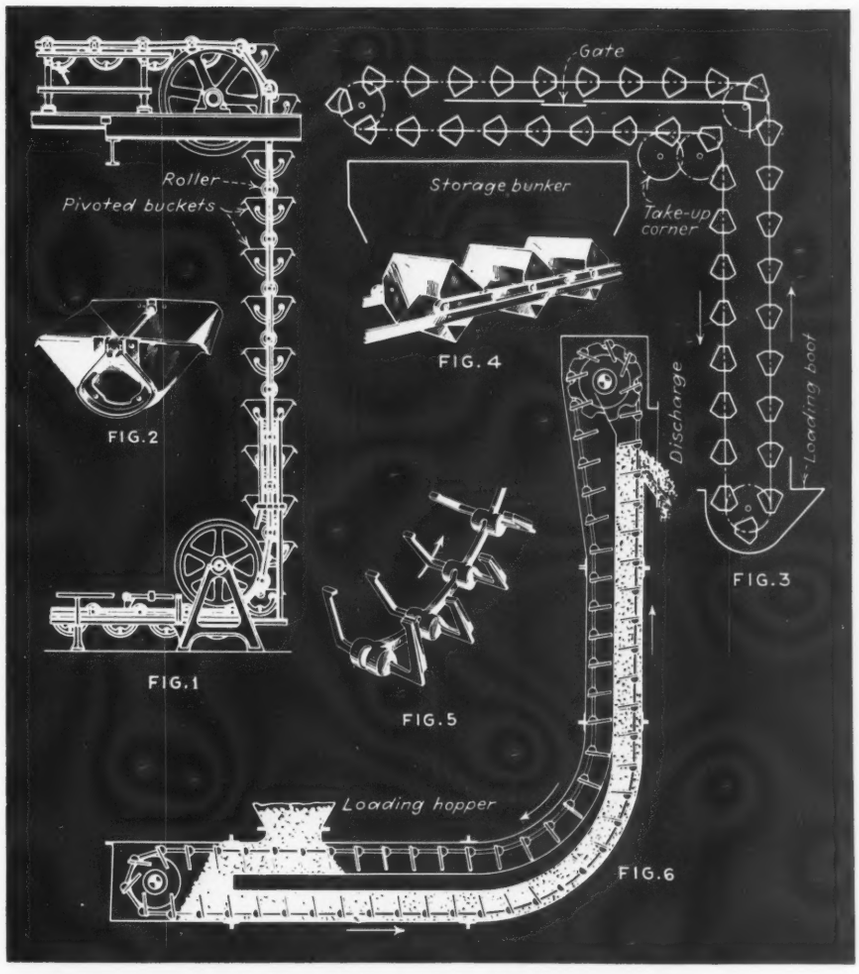
Buckets can be loaded from a boot, Fig. 3, or from a horizontal run. With the latter arrangement, coal is fed into a trough through which the buckets run. This trough extends up around the sprockets, in front of the loading point, to insure proper loading of the buckets.

A Redler elevator and conveyor, Figs. 5 and 6, handles coal in practically any direction. It consists of an enclosed steel casing, through which the conveying element travels, Fig. 6. The conveying element is an endless series of closely spaced U-shaped skeleton flights, Fig. 5. The conveyor feeds itself at any point, with a uniform load that fills the conveying compartment and entirely surrounds the conveying element.

When the flights move, they cause the material to flow forward or upward with the flights in a solid column. The load can be discharged at any opening where the material can fall away from the flights. Fig. 6 shows loading on the horizontal flight and unloading from the vertical lift, but this arrangement can be reversed.

The most flexible type of coal-handling system yet devised is a heavy-walled rubber tube, split longitudinally, Fig. 7. Each half of the moving conveyor tube is really an endless rubber belt with a chain imbedded in it to give mechanical strength. The chain carries the load and the rubber acts as a casing to hold the coal. Double-tongue-and-groove joints seal when the belts are put together.

At the loading hopper, the two halves of the tube divide and run around separate sheaves. Coal flows into the load half of the tube which then passes under the sheave around which the cover half of the tube runs. This forces the two halves together, after which the assembly is given a twist to compress the joints and pre-




Figs. 1 and 2—Pivoted-bucket carriers. Figs. 3 and 4—Gravity-discharge elevators. Figs. 5 and 6—Redler conveyor and elevator.

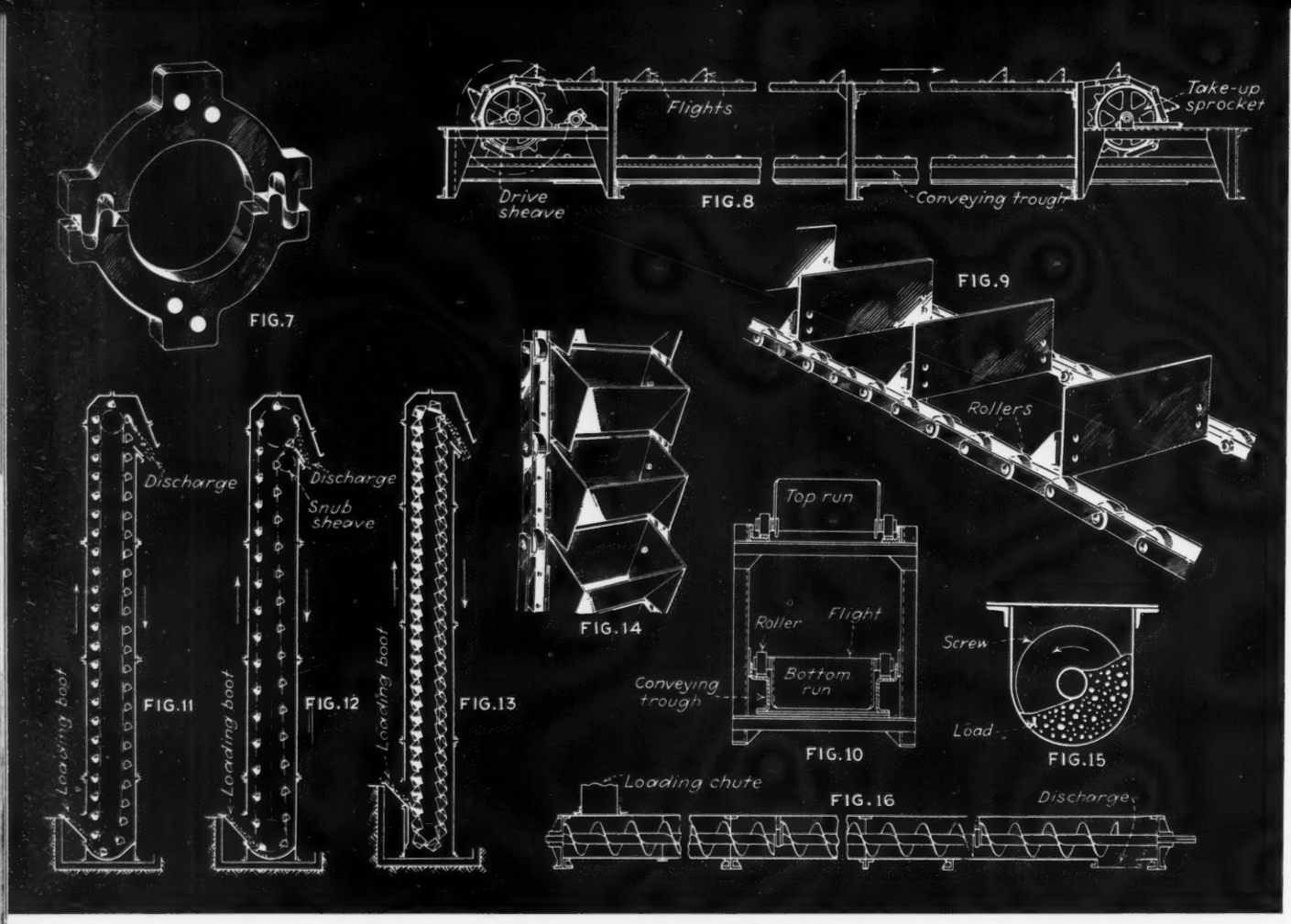



Fig. 7—Section of Johns rubber conveyor hose. Figs. 8 to 10—Flight- or drag-type conveyor. Fig. 11—Centrifugal-discharge bucket elevator. Fig. 12—Perfect-discharge bucket elevator. Figs. 13 and 14—Continuous-bucket elevator. Figs. 15 and 16—Screw or spiral conveyor

vent the tube from opening. In emptying, guide rollers first remove the twist from the unloading section of the tube, leaving the joint vertical. Then the two halves separate directly over the discharge hopper and dump the load, pass over separate drive sheaves and are resealed.

A flight or drag conveyor, one of the first machines developed for handling materials, consists of a series of flights or plates supported on one or between two chains, Fig. 9. The plates push the coal along in a steel trough, Figs. 8 and 10. The trough may be provided with gates at intervals to permit discharge at desired points or at the end of the trough. Either the top or bottom strand may do the conveying, but in most installations, it is the bottom one. These conveyors are well suited to moving coal horizontally or up inclines of 20 to 45 deg at rates of 30 to 360 tons per hr.

Where small capacity, up to about 75 tons per hr is required, bucket elevators can be used. They comprise a series of malleable-iron or steel buckets, which for handling coal or ashes, are usually mounted on one or two endless chains, but they may be attached to a flat belt. They are of three general designs; centrifugal discharge, Fig. 11, perfect discharge, Fig. 12, and continuous bucket, Fig. 13.

Buckets on the centrifugal-discharge type are spaced at intervals and bolted to a single chain that runs on a head and a tail sprocket. Material either flows into the buckets or is scooped up from under the tail sprocket. The buckets travel at sufficient speed, 175 to 300 fpm, to discharge by centrifugal action as they pass over the head sprocket.

### Perfect-Discharge Elevator

The perfect-discharge elevator has its buckets supported between two chains, with the return line snubbed back under the head sprocket, Fig. 12, so that all material falls from the buckets directly on a deflector plate or chute. Chain speed ranges from 75 to 125 fpm, so as not to throw the material.

Buckets on the continuous-bucket elevator are placed close together on one or two chains, Figs. 13 and 14, and loaded by coal flowing into the buckets. Spillage between buckets is prevented by close spacing and, at the sides and front, by a loading leg. When the material discharges, it passes over the front of the preceding bucket, on which front and projecting sides form a chute to deliver into the fixed discharge chute, Fig. 13.

A standard screw or spiral conveyor comprises a spiral on a shaft turning in a U-shaped casing, Figs. 15 and 16. In horizontal and inclined designs, the casing is partly full, Fig. 15, and material is pushed ahead by the screw like a nut on a bolt. Although usually used for horizontal installations, or inclined up to about 30 deg to horizontal, screw conveyors are built for vertical operation. Screw conveyors are available with screw diameters of 3 to 24 in., and for capacities up to 200 tons per hr, depending upon size of coal. Speeds are slow, usually between 75 and 125 rpm.

Apron conveyors, described on page 56, are well suited for handling bulky and heavy abrasive materials containing large lumps, as coal. Their principal applications for handling coal are as feed conveyors on short runs where severe conditions are encountered at loading. They can be operated on inclines up to 25 deg, at speeds of 10 to 100 fpm and are built in widths of 18 to 60 in. for capacities up to 300 tons per hr.

# PORTABLE CONVEYORS

▶ WHEN COAL has to be unloaded from gondola cars or discharged from dump-bottom cars at ground level, without a track hopper, special handling problems are encountered. For these jobs, many types of semiportable and portable conveyors and other equipment are available. Even though none of them completely eliminate hand shoveling, as do properly installed stationary handling equipment, they greatly reduce manual labor, speed up handling and reduce costs in many applications. Furthermore, large coal-truck bodies are often high enough to make necessary a conveyor if loading is from ground storage.

Unloading gondola cars offers a difficult problem of applying labor-saving equipment. One device has been described, Fig. 1, page 50. Another method is a portable crane and grab bucket, used when enough cars are unloaded to justify cost of equipment.

A short bucket elevator supported on a chain fall and trolley for unloading gondola cars is shown in Fig. 1. If the storage yard is a car length long, then unloading can start at one end of the car and the elevator gradually moved to the other. With either the belt or bucket unloader, considerable labor is required to bring coal within reach of the conveyor.

Unless coal storage is so located that cars must be unloaded over the side, or coal is to be shoveled from the car into trucks, it is best to have coal delivered in dump-bottom cars. Manual labor for unloading this type of car can be practically eliminated by semiportable or portable equipment.

Portable conveyors are usually of the belt type, Fig. 2, or the drag type, Fig. 3. These conveyors are built in many forms and sizes and are built to be moved manually or by power. When loading coal from a ground pile, manually moved conveyors are generally only partially self feeding, a certain amount of labor being required to scrape or shovel the material into them. Power-moved units are, under most conditions, entirely self feeding, the mobile power unit being used to force the conveyor into the pile to keep it loaded. Self-propelled, self-feeding bucket elevators are also used for loading coal and other material from ground storage to trucks and railway cars.

When coal is unloaded to ground storage or to trucks from dump-bottom cars at ground level, portable conveyors can be applied in three ways. Shallow excavations may be made at unloading points outside the rail, into which the feed end of a portable conveyor can be placed. With this arrangement, most of the coal in the car flows to the conveyor, without shoveling or raking, when the hoppers are opened. Planking or steel plate placed over the rails under the hoppers, and around the coal where it comes from the car, will facilitate moving it to the elevator.

A shallow concrete pit is recommended where a considerable tonnage has to be handled. Practically all coal falling from the car will then feed into the conveyor, permitting rapid unloading with a minimum of labor.

### Unloading Conveyor

A third method uses an unloading conveyor placed directly on the rails under a car hopper so that coal will discharge onto it, Fig. 4. The unloader extends more than 2 ft beyond the far rail of the unloading track. It thus can receive practically all the coal falling from the car. The unloader discharges into a portable conveyor that can be swung through a wide angle to distribute the coal on the storage pile or into trucks. Planking placed around the track section, Fig. 5, will guide the coal to the conveyor with practically no spillage. Either belt or drag conveyors are used as unloaders. Their receiving end is made very thin to take a minimum of space under the car and their discharge end is elevated for delivery to the receiving end of a distributing conveyor.

Only a few of many ways that portable conveyors can be applied to handling coal and ashes have been mentioned, but these indicate that they have an important place in material-handling problems.

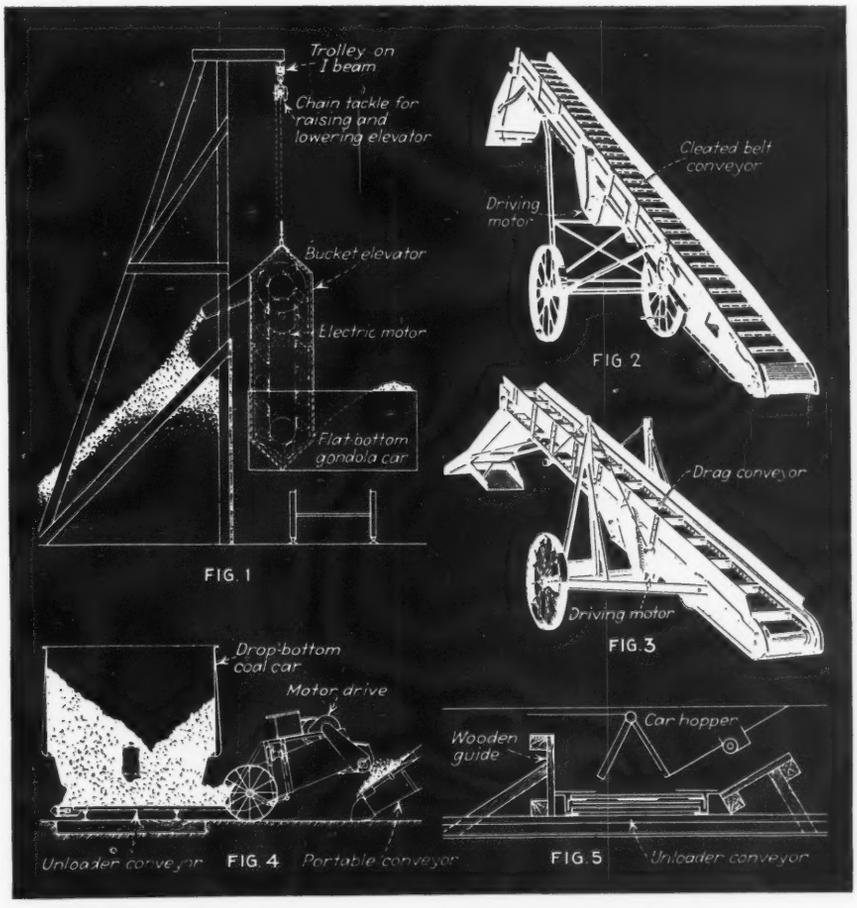



**Fig. 1—A short bucket elevator supported on chain fall and trolley for unloading gondola cars. Fig. 2—Belt-type portable conveyor. Fig. 3—Drag-type portable conveyor. Fig. 4—Unloader conveyor under a dump-bottom coal car. Fig. 5—Boards blocked at an angle guide coal to portable unloader conveyor**

# COAL WEIGHING

▶ POWER PLANTS cannot be operated efficiently on potluck. Detailed information must be available on operating costs so that they can be analyzed and controlled. Fuel is the major expense in running a steam plant and knowledge of its quality and quantity is essential to intelligent operation. How weighing of coal is done will vary with conditions, there being many methods and types of equipment available, both manual and automatic.

Where coal is received by railway car in large quantities, track scales are frequently installed for weighing as received. Weighing can be done either manually or automatically, the latter being preferred because it eliminates errors. Systems of automatically weighing car loads in motion, first used on railroads, have been adapted to railway track scales for large power plants. In some large plants, cars are weighed before and after unloading to obtain the net weight of coal delivered. Other large plants use a rotary car dumper, Fig. 1, mounted on a scale to weigh the loaded car, dump it, and then weigh the empty car.

An automatic-weighing feeder installed between the receiving hopper and conveyor leading to the bunker provides an answer to the problem of weighing coal as received. One type is shown in Fig. 2. This unit consists of a vibrating feeder supported independently of a weigh belt on a scale beam, and an automatic electric control. The weigh belt, driven by a synchronous motor, travels at a constant speed. On the scale weigh beam is an adjustable counterpoise. With the counterpoise at zero and the weigh-belt empty, the weighing system is in balance. Setting the counterpoise away from zero establishes the weighing rate.

Fig. 4 shows a volumetric method of weighing coal. Coal is delivered from a receiving hopper onto a feeder conveyor or traveling-grate stoker. The belt is driven at constant speed and coal-bed thickness is controlled by a gate connected to a counting wheel in the coal meter. On its top side, the counting gear meshes with a long gear driving a recording counter. On its bottom, the counting wheel meshes into a toothed spiral drum driven from the conveyor shaft. When the feed gate is in full open position, the counting wheel will be over to the right-hand end of the spiral drum and will be in mesh for the entire revolution of the drum. With the gate close to minimum feed position, the counting wheel will be moved over to the left where the spiral drum will mesh with it for only a small part of a revolution and the counter will record proportionately. Between these two extreme positions, speed of the counter will vary with the position of the gate and counting wheel.

Where belt conveyors are used, automatic weightometers may be installed in them to record continuously total weight of coal carried on the conveyor.

**Fig. 1—Rotary car dumper mounted on a scale weighs the loaded car, dumps it, and then weighs the empty car. Fig. 2—Automatic-weighing feeder conveyor. Fig. 3—Coal meter operated by a vane in coal spout to stoker**

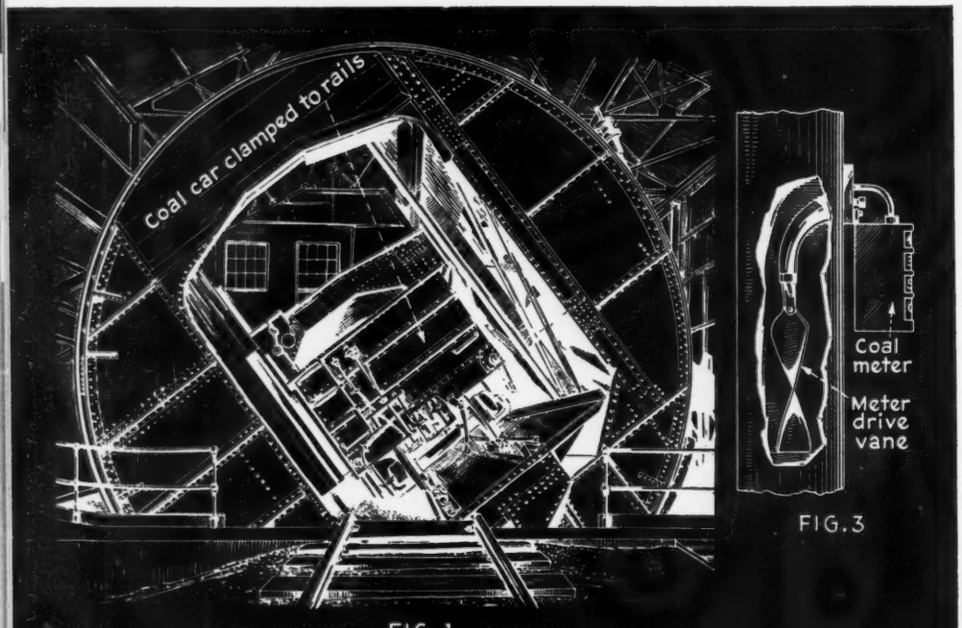



FIG. 1




FIG. 3

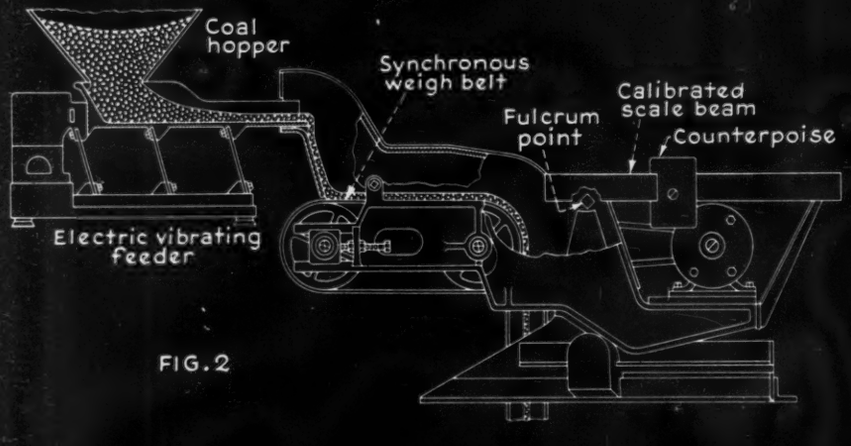



FIG. 2

## Barge Delivery

At some plants, where coal is received by barge, it is delivered directly by a clamshell bucket into the bunker, which doesn't allow opportunity of weighing. When coal is delivered by clamshell bucket to a conveying system, any of the previously-described methods of weighing applicable to conveyors, can be used.

Another method is to dump coal into a temporary storage bunker, from where it is charged into larry cars, pulled by an endless cable. The cars, on their way to dump in the bunker or storage yard, pass over an automatic scale which prints the net weight of coal on a tape.

Electrically operated hopper cars, with hoppers mounted on scales, are also used to deliver coal from a temporary hopper to bunker. The scales automatically record the weight of the load and the operation of the cars can be manually, remotely or automatically

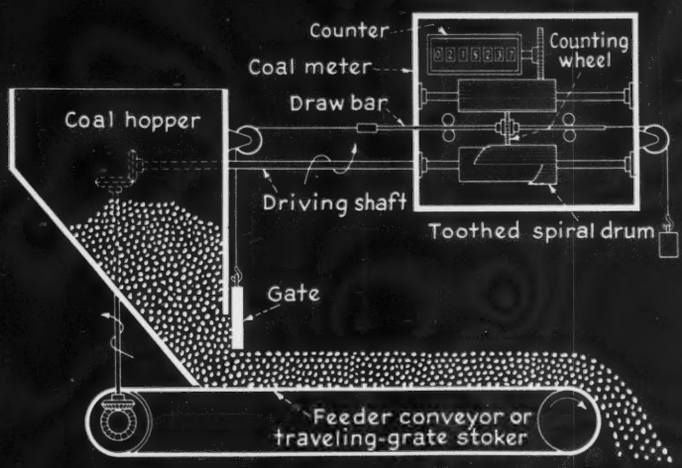



FIG. 4

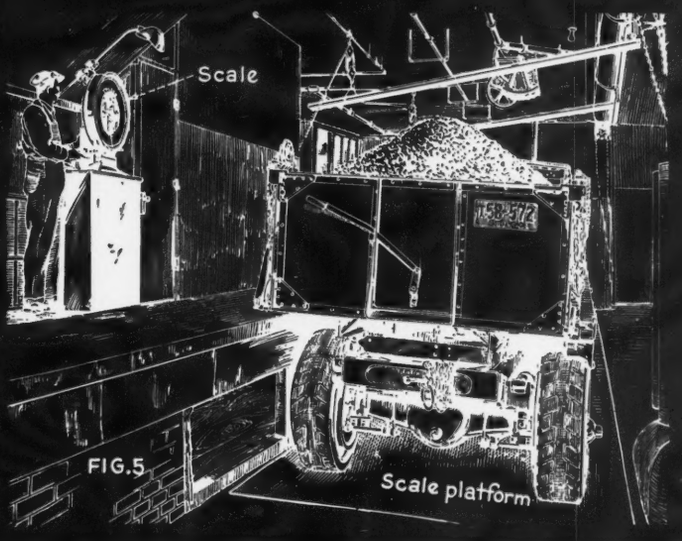



FIG. 5

FIG. 6

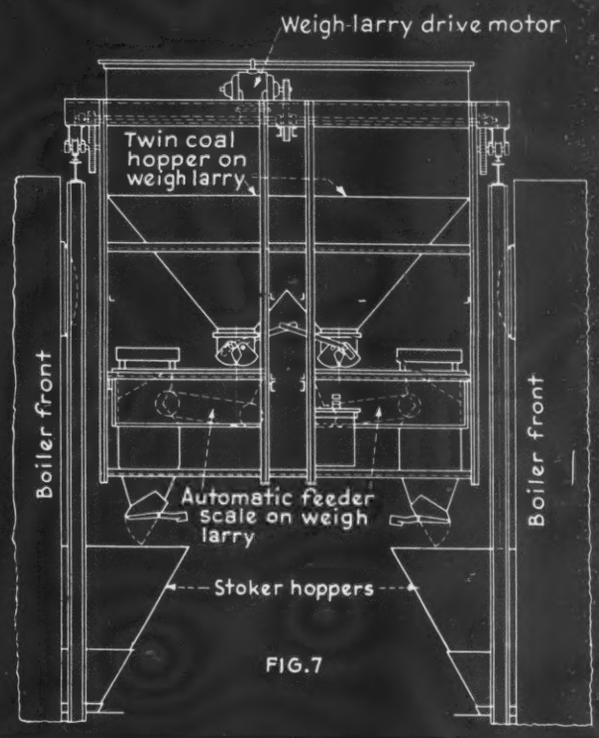



FIG. 7

**Fig. 4—Volumetric method of weighing coal. Fig. 5—Coal as received by truck is weighed on a platform scale. Fig. 6—An automatic revolution counter on the stoker shaft permits estimating weight of coal fired. Fig. 7—Twin weigh larry with automatic feeder scales, weighs coal to stoker hoppers**

controlled. When coal is received by truck it can be weighed on a platform scale, see Fig. 5.

Weighing coal to each boiler is of even greater importance than weighing it as received. This record, with steam-flow data, provides necessary information for a continuous check of plant performance. Even where it may not be convenient or economical to weigh coal as received to small plants, any plant can and should weigh the coal as fired. In hand-fired plants where coal is brought to the boiler by wheelbarrow, loads can be weighed on a scale and a record kept. In some small hand-fired plants, coal from storage is loaded into a specially designed car and each load is weighed on a scale that automatically records weight.

When coal is received in an overhead bunker, the bunker may be calibrated and then, by keeping a record of coal delivered, the amount burned in a given period can be determined. Some operators have been able, by this method, to obtain a fairly close check between weight of coal taken out of the bunker with that delivered. A much better method is to dump the coal in a car and weigh it, or install coal meters, Fig. 3, in the coal pipes leading to the boiler room or stokers. The meter is operated by a vane projecting down into the center of the coal spout. Another type of coal meter is driven by an endless chain instead of a vane.

### Counters, Tachometers

With underfeed stokers or constant-volume feeders on pulverizers, a revolution counter may be installed to record revolutions of the feeder or stoker shaft, Fig. 6. Then, knowing the volume of coal delivered by each stoker plunger or per revolution of the feeder, operators can estimate weight of coal. By using a specially designed and calibrated tachometer, coal weight can be recorded on the boiler-meter chart. With one or more coal spouts leading to each stoker or pulverizer feeder, coal meters give a convenient record of coal as fired.

A weigh larry is one of the most generally used methods of weighing coal to stoker-fired boilers. Many forms are available: they are manually or power operated depending upon capacity, and arranged for either manual or automatic weighing and recording. They are suspended on overhead tracks, Fig. 7, or run on tracks in the boiler-room floor. Generally, they are loaded from an overhead bunker, but they can also be loaded with a portable conveyor from a coal pile on boiler-room-floor level.

Semi-automatic weigh larries are available. With these, when the boiler attendant presses a button in front of a boiler, the larry, which has been automatically loaded, travels to the selected boiler. After dumping its load into the stoker hopper, the attendant releases the larry and it returns for another load. With a single vertical bunker at one end of the boiler room, as now used in many plants, a weigh larry is practically a necessity to convey coal to the stokers.

Weighing of coal is very much like the problem of coal handling: there is no standard way of doing it. One thing is certain, however. Weighing of coal to each boiler will pay big dividends if the information thus obtained is used intelligently to improve plant operation.

# ASH HANDLING

► ASHES REPRESENT only a small percentage of the coal burned, but no matter whether coal is burned by hand-firing on stationary grates, on automatic stokers, or in pulverized form, ash removal is a major power-plant problem. The dusty abrasive character of ashes makes the problems of their disposal comparable with those involved in coal handling.

Ash-handling equipment ranges from the shovel to entirely closed and fully automatic systems. With hand firing on stationary grates, the fires are cleaned periodically by raking the ashes off the grates onto the firing-aisle floor. If hand firing is done on dump grates, ashes are dumped below the grates and then, in most plants, hoed out onto the boiler-room floor.

Once the ashes are on the firing-aisle floor, removal to outside the plant may be accomplished in any of several ways. First, the least desirable is to shovel them into a wheelbarrow and dump them on a pile outside the plant from where they are again shoveled into a truck for final disposal. This, to say the least, is a dirty, backbreaking, uneconomical way of doing the job. Even in small plants, some form of portable or permanent elevator conveyor can be put in to load the truck.

### For Buildings

If the power plant is in a building basement, then ashes must be elevated to street level for disposal. In one commonly used method, ashes are shoveled into cans, then hoisted to street level by a sidewalk elevator, and dumped by hand into trucks. Hand-operated or power-operated hoists are available for lifting the cans from the basement up to where they can be easily dumped into the truck.

Telescope bucket elevators, Fig. 1, elevate ashes from the basement and discharge them directly into a truck. As shown, this elevator comprises a lower stationary section of bucket elevator and a top section that is counterweighted and arranged so that it can be moved vertically up or down by a cable wound on a drum.

When the top section of the elevator is down, a thin flat steel plate on top of it rests on the sidewalk to seal the hole through which the elevator moves. In its elevated position a spout at the discharge of the elevator can be pulled out to permit flow of ashes directly into a truck. A receiving spout at the lower end of the elevated section matches with the discharge of the stationary unit so that one discharges directly into the other.

### Steam Ejector

Manual ash handling, even in small plants, is not necessary, because equipment is available to take ashes directly from hand-fired boilers. A steam-ejector system of this kind is shown in Fig. 2. This system, easily installed in the boiler-room floor, consists of a 4-, 6- or 8-in. pipe with intake fitting, Fig. 3. One intake fitting is installed in front of each boiler flush with the floor level. These fittings are closed by covers when not in use.

In Fig. 2, the steam nozzle is located in the 90-deg. elbow at the bottom end of the vertical riser. Fig. 5 shows a cross section of the nozzle and elbow construction. Removable liners are provided for those sections of the elbow where the greatest wear from ashes occurs. These are made of chilled cast iron with Corundum inserts. Removable liners also protect the elbow at the top of the riser.

The conveying pipe terminates in a baffle box, Fig. 4, at the top of the ash tank. Ash pockets in the baffle plate prevent wear of the plate. The feed pipe, Fig. 2, is always open at the free end so that when steam is turned on the nozzle, air at high velocity is drawn through the pipe to carry the ashes forward as they are fed into the pipe.

Modern stoker-fired boilers are usually provided with large-capacity ash hoppers on their discharge, Fig. 8, from which the ashes can be removed conveniently. With pulverized coal-fired boilers, the ashes are largely in the form of flyash for dry-bottom furnaces and slag for slag-tap furnaces. The ash hopper, Fig. 8, with a capacity sufficient for 8- to 16-hr operation of the stoker, is built of either $\frac{3}{8}$-in. thick copper-bearing steel plate or $\frac{1}{2}$-in. cast iron supported in structural-steel frames and lined with vitrified shale brick laid on edge in cement mortar. Nozzles are provided near the top of the hopper to quench the ashes and a stationary drain on each ash gate disposes of excess water.

Soot from the boiler is piped into the ash hopper from where it is discharged with the ashes into a manually propelled end-dump car. The car is pushed to the end of the boiler house and dumped into the bucket of a skip hoist, which discharges the ashes into an elevated storage tank, Fig. 6. From there, they can be conveniently loaded into a truck or railroad car.

Fig. 7 shows a similar ash-handling system in which the skip hoist is used for handling either ashes or coal. The skip discharges into a divided storage tank, one part for coal and the other for ashes. Since the material in a skip bucket does not come in contact with

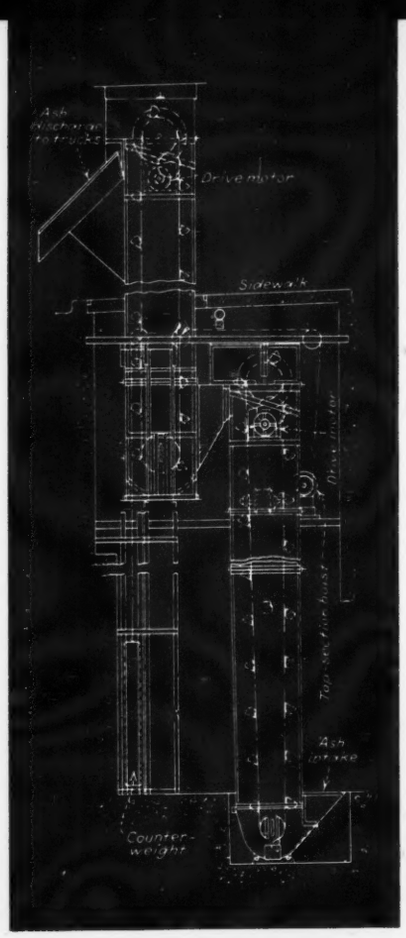



Fig. 1—Telescope bucket elevator for removing ashes from building basements

(Right) Figs. 2 to 5—A steam-jet ash-handling system and its parts. Figs. 6 and 7—Ashes are taken from stoker hoppers into cars and dumped into a skip hoist. Fig. 8—Ash and siftings hoppers below an underfeed stoker. Fig. 9—Drag conveyor discharges ashes, taken from stoker hoppers, into a bucket elevator. Fig. 10—Hydraulic system of sluicing ashes from stoker hopper and conveying them away. Fig. 11—Removing ashes with grab bucket from sump. Fig. 12—Cross section through one type of ash-handling pump

any of the running gear, it is both economical and practical to handle ashes in the skip bucket when provisions are made in the control to insure ashes and coal being discharged into their respective storage compartments.

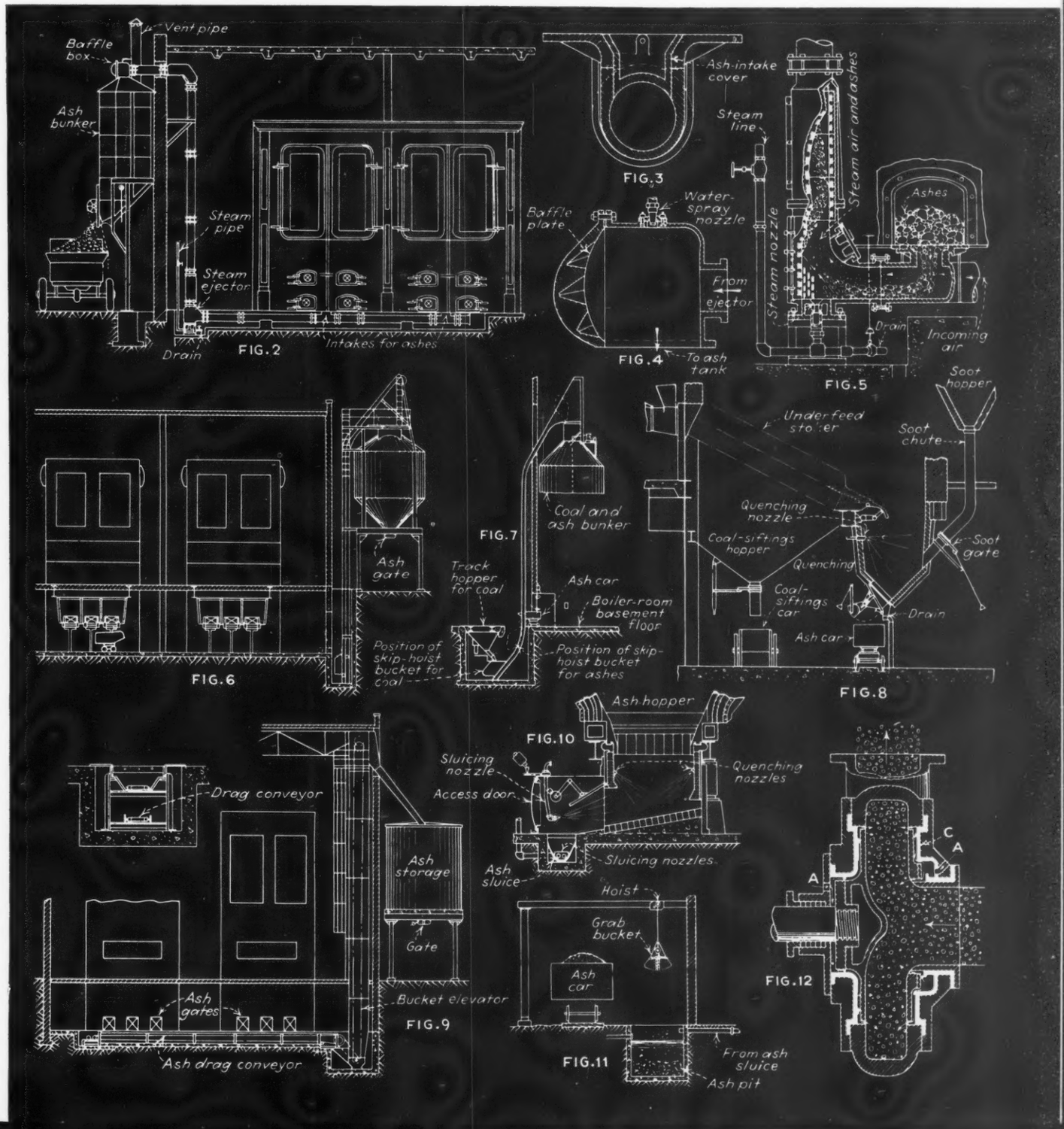
For the larger-size plants, ashes and coal may be stored in separate bunkers by the same skip hoist, or one skip hoist may be used for coal and another for ashes. Pivoted bucket run-around conveyors are also used to handle either coal or ashes, as in Fig. 11, page 52.

Where the ash pits are too low to permit dumping into cars, a drag conveyor may be installed in a trench in the boiler-room floor, see Fig. 9. Gratings are provided over the loading points along the conveyor to prevent large clinkers and other objects from dropping into the conveyor and to protect the attendants. Ashes raked from the stoker-storage hoppers fall into the conveyor and are discharged into the boot of a bucket elevator, which delivers them into a chute leading to the ash-storage tank.

## Steam-Jet System

A steam-jet system, Fig. 2, may be installed in the boiler-room basement floor, like the drag conveyor, Fig. 9, to discharge into an ash tank. If the ashes can be trucked away regularly, the ash tank may be dispensed with and the ashes discharged directly from the conveyor into the truck. Or the ashes may be discharged into a storage pile outside the plant and loaded into truck or railroad cars with a portable conveyor.

Water jets are widely used as a conveyor system, particularly in medium-size and large plants. In this system, high-pressure water jets flush the ashes out of the stoker hoppers into a sluiceway, Fig. 10, where they are conveyed by other high-pressure jets into a sump, Fig. 11, or discharged onto waste land for fill. When deposited into a sump, they are pumped out into an elevated storage tank, water from the tank returning to the sump. A grab-bucket handled by a hoist, as in Fig. 11, is also used to remove ashes from the sump. This sys-



tem is also used for handling flyash or molten slag from pulverized-coal-fired boilers. Slag from slag-tap furnaces is allowed to run down into the water jets where it is suddenly cooled into a granular form, easily carried away with the water.

Abrasion by ashes on pump parts is extremely severe in this service. Consequently, they must be made of materials highly resistant to wear, even though they may operate for short periods only each day. Wearing parts of one line of pumps for this service are made of manganese steel. Runner, volute and suction nozzle of the pump, Fig. 12, are made of chrome-nickel-molybdenum steel heat-treated and ground to dimensions. A removable soft-rubber covering *C* is placed between the runner and casing to take wear. Clear water admitted under sufficient pressure at *A* to flow into the pump lubricates the running clearances and keeps abrasive material from getting into them.

Heavy-duty pneumatic conveyor systems have been developed for handling ashes, flyash and soot for large power plants, one type of which is shown in Fig. 13, applied to a chain-grate-stoker-fired boiler. This system comprises a positive-displacement rotary blower, an air washer and an ash receiver. The latter, through a swinging discharge gate, discharges into an ash-storage tank. To operate the conveyor, the motor-driven blower is started. This exhausts air from the ash receiver, located on top of the ash-storage tank, which causes an inrush of air past the swinging discharge gate, closing it tight. A high-velocity flow of air through the ash-conveying pipes is then created. The operator opens an ash-pit gate, allowing ashes to flow into the conveyor intake from where they are carried to the receiver by the air.

Ashes enter the circular receiver at a tangent, which produces a whirling action to separate them from the air and they drop to the bottom of the receiver. Air passes out at the top and enters the air washer to remove any remaining dust before the air enters the exhauster. At intervals of about 90 sec, the air-release timer opens a large relief valve. This shuts off suction on the receiver for about 5 sec to permit the swinging discharge gate to open and dump the ashes into the storage tank. Then, the timer closes the relief valve and the cycle repeats. During the shut-off period, the ash gate is not closed. Any ashes accumulating in the intake during this period are drawn away when suction starts again. This system is also installed with a multi-jet steam exhauster between the ash receiver and air washer.

Where coal is burned in pulverized form, much of the ash is caught in the boiler, economizer and air-heater sections, in the breechings and in the base of the stack. These parts may be remote from each other, making a manually operated ash-handling system inconvenient. This has led to fully automatic and remotely controlled systems, one of which is shown in Fig. 14. This is a vacuum system using high-pressure water jets as the evacuating medium, Fig. 15. Connection between the system and each ash or dust hopper is by a rotary valve, which is closed, except when ashes or dust are being removed.

## Dust Valves

In Fig. 14, the dust valves are electrically operated from pushbuttons assembled on a control panel, along with a vacuum gage to indicate the vacuum in the system. After the hydrovactor ejector has been started and the vacuum gage shows almost a perfect vacuum, the operator presses a button to operate one of the dust valves. When the dust hopper is empty the vacuum-gage reading drops nearly to zero, after which the operator closes this valve and opens another, continuing this until all hoppers are cleaned.

In some plants, where soot contains a percentage of carbon, it may be returned by the dust-handling system to the furnace and burned. Fig. 16 shows one system for doing this. A dust-removal system of the steam-ejector type discharges dust into a burner where it mixes with necessary combustion air.

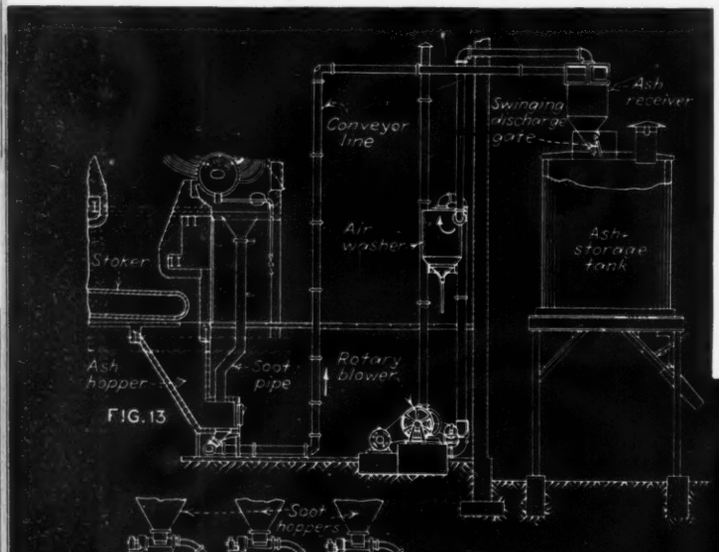


FIG. 13

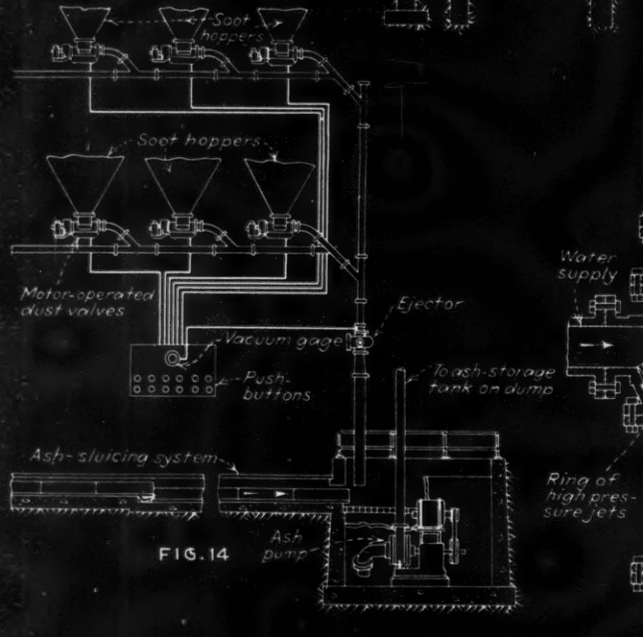


FIG. 14

**Fig. 13—Pneumatic system of ash-handling applied to traveling-grate-stoker-fired boiler. Fig. 14—Remotely controlled system of soot removal combined with hydraulic ash-handling system. Fig. 15—Cross section through valve and hydraulic evactor used on the system. Fig. 14. Fig. 16—System for discharging soot to burner in furnace**

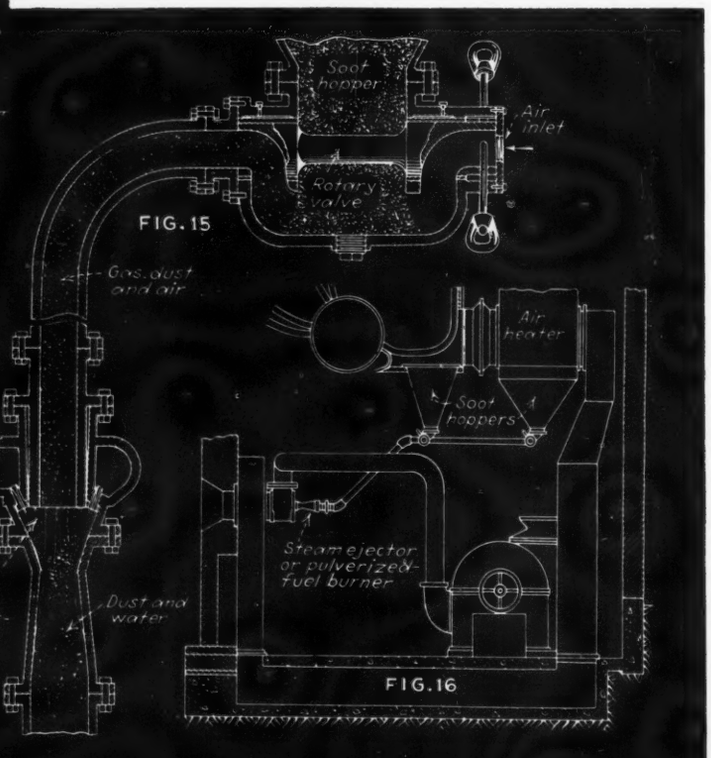


FIG. 15



FIG. 16

# BUNKERS AND SILOS

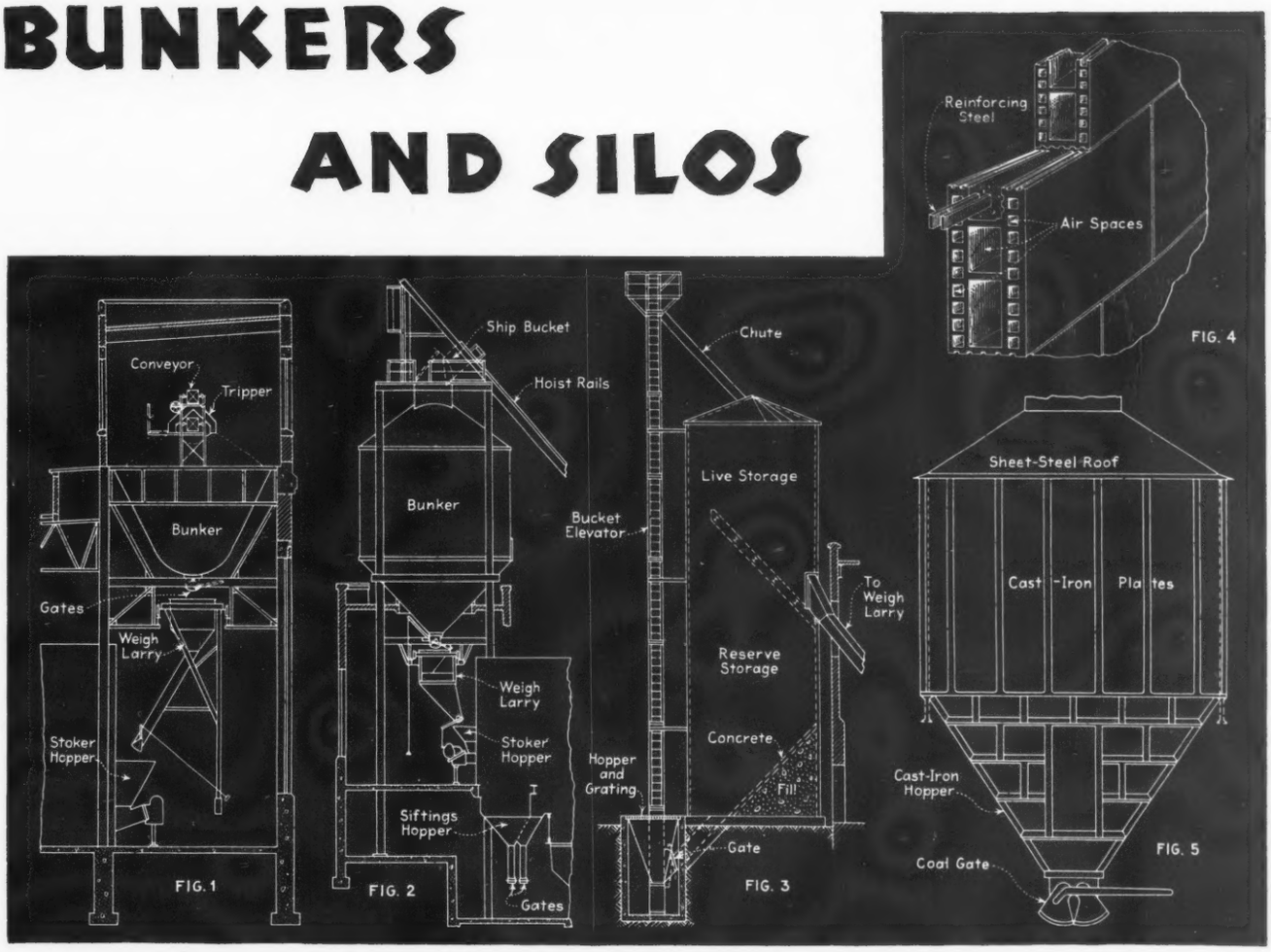



**Fig. 1—Suspension-type steel-plate bunker in which coal is distributed by a belt conveyor and automatic tripper, and is delivered to stokers by a weigh larry. Fig. 2—Overhead cylindrical bunker with conical bottom and center discharge. Fig. 3—Reinforced-concrete silo arranged for live storage in top half and reserve coal storage in bottom. Fig. 4—Section of vitrified glazed-tile ash-storage tank. Fig. 5—Sectional cast-iron coal- or ash-storage bin**

▶ SOME FORM OF OVERHEAD storage bunker or silo is part of most coal- and ash-handling systems. Several kinds of material, such as reinforced concrete, steel plate, cast iron and special tile, are used in the construction of many types of bunkers and silos.

In earlier designs of power plants, with long rows of stoker-fired boilers, the overhead suspension bunker, Fig. 1, came into wide use. Not infrequently today, this type of bunker is preferred to obtain minimum height of boiler plant, to eliminate the tower usually associated with cylindrical bunkers, to provide storage capacity where regular receipt of coal cannot be insured, and to serve a long row of boilers under conditions that make the cylindrical bunker impractical.

Today, there is a decided tendency to store skyward in elevated cylindrical storage tanks, Fig. 2, or in silos, Fig. 3. The cylindrical bunker is generally provided with a conical bottom and single outlet. This gives a homogeneous discharge from the bunker to reverse the segregation process that occurs when filling, providing a uniform mixture of coal sizes.

Where more storage is required than can be obtained with a cylindrical bunker, an outdoor silo, Fig. 3, may be used. One or more silos are installed according to storage required. They are generally built of monolithic reinforced concrete or vitrified interlocking tile set in concrete and reinforced circumferentially by steel rods, cast into the concrete. The tiles are made with air spaces, see Fig. 4, to prevent freezing inside the silo during cold weather. In some cases, coal is drawn directly from the bottom of the silo to the boiler by a conveyor. More frequently a division is placed in the silo, as in Fig. 3, above which is live storage. Any coal delivered in excess of what the live storage will hold flows into reserve storage in the bottom of the silo, from where it is returned to live storage as needed by the coal-handling system.

Coal and ash storage may be combined into either cylindrical overhead bunkers or in silos, or separate ash-storage tanks may be used. These tanks are frequently made of vitrified tile heavily glazed on all four sides. This surface is impervious to acid and moisture. Fig. 4 shows one design of these tiles for the circular wall of the tank. A channel in the top of the tile permits placing reinforcing steel bands in cement used in each course of tile.

## Cast-Iron Plates

Cast-iron plates are also used for coal- and ash-bunker construction. These bunkers are made square, octagonal and oblong-octagonal in cross-section with inverse pyramidal bottoms. The plates are flanged and where possible, all bolts are in the flanges outside the bunker. The bunker is supported on a steel structure in such a way that bunker contents never come into contact with the supporting members, and is built in capacities up to 300 tons or more.

# FUELS THAT FLOW

▶ SYSTEMS FOR HANDLING pulverized fuels, oil and gas consist mainly of piping. These fuels are carried from storage to burner under pressures ranging from a few inches of water for gas fuel to 50 lb or so for oil. Except for a degree of fire and explosion hazard, transport problems are simpler than for solid fuels.

Storage of pulverized fuel and gas, however, involves major difficulties in plants designed primarily for power production and is eliminated whenever possible. Most recent plants burning pulverized coal, for example, fire directly from the mill, whereas earlier designs provided a storage bin between pulverizer and burner for reliability of coal supply. Developments in mills and transport systems have resulted in so-called "unit systems" equal in reliability to the bin-storage systems without the hazard and inconvenience of the bin.

## Pulverized Fuels

MANY OTHER FUELS beside bituminous coal are transported in pulverized or relatively finely divided form. These include anthracite, pitch, petroleum coke, sawdust, wood chips and even oat hulls. Insofar as the particles of fuel are carried along by a stream of rapidly moving air (in suspension), they are handled exactly as steam or water in piping, transport air being supplied by a fan.

The most common of these, of course, bituminous coal, ground in a mill to a fineness of about 0.0025 in, needs air flow enough to maintain a velocity of 3500 fpm or more to prevent deposits and plugging in the lines. Other fuels require flow in proportion to size and weight of particle. The air for transporting the fuel is usually introduced into the furnace along with the fuel and makes up 10 to 15% of the air required for combustion.

The fan either supplies air at a slight pressure to the mill or exhausts air-coal mixture from the mill, keeping it under suction. The former location requires that the mill be dust proof, but fan-blade wear is eliminated because the fan handles only clean air. The exhaust-fan arrangement can be used with any type mill; fan rotors are designed for easy and inexpensive maintenance and give reasonable life. One figure quoted for fan-blade service is 20,000 tons of coal before replacement was necessary.

Early pulverized-fuel systems were designed to store 100 tons or more of the fuel in the pulverized state, the so-called bin-and-feeder system. Fuel supply was considered more reliable in event of pulverizer shut-down than if the mill supplied the furnace directly without storage. The former system entailed greater initial cost and presented additional explosion hazards due to the bin and associated equipment. The latter depends on the reliability of the mill. Improved mill designs, two or more mills per boiler, spare mill capacity and improved control of fuel flow have removed most of the objections to the unit system and most new installations are of this type.

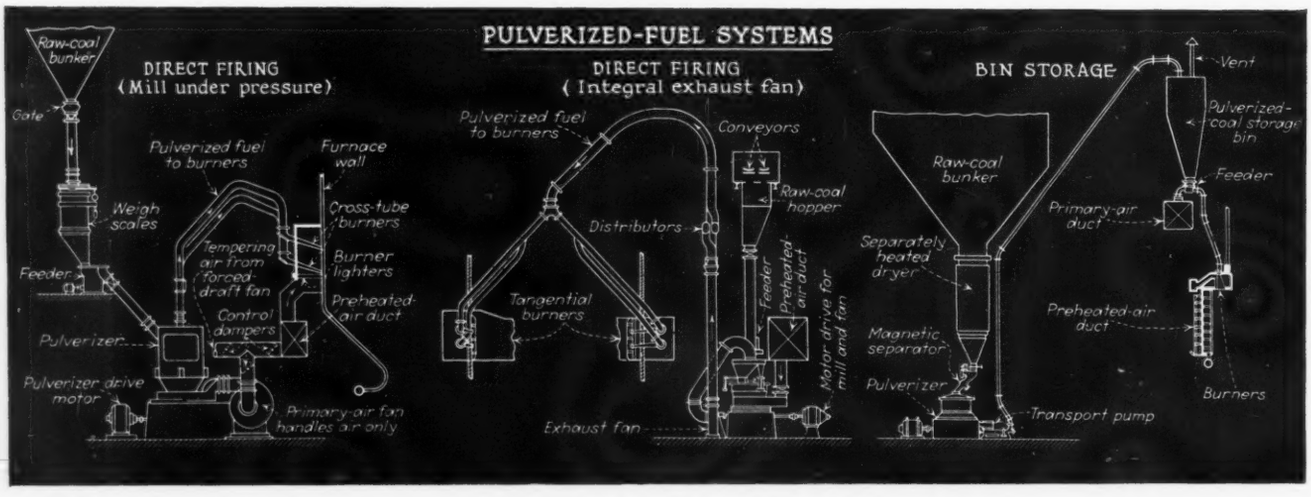
Piping for pulverized-fuel transport should be as short and direct as possible, short-radius bends should be avoided and wearing plates or extra thickness of metal should be provided at bends. Piping should be designed for 3500-fpm velocity or more and horizontal runs avoided if possible. Ample supports should be provided, pockets and projections inside the pipe avoided and laterals used for branch piping. Piping should be insulated against temperature changes and connections provided for introducing compressed air for purging the system of fuel particles and for cleaning plugged lines.

Shut-off gates of the sliding type or any of several ingenious cap-lever closing designs are preferable to butterfly valves which tend to collect particles and clog. When open, operating parts of such valves should be out of the flow stream to minimize wear. One design uses a rubber valve seat for longer life.

### Piping

Regular flanged piping, standard weight or extra heavy, is usual, but many recent installations are welded. Corrosion can occur if condensation of moisture is permitted in the piping after shut-down.

Fires can work their way back up through the burner and into the supply piping if fuel is allowed to accumulate. Occasional rapping of the pipe, careful purging with compressed air and introduction of a small amount of air to a dead burner to keep it reasonably cool are effective in reducing trouble from this source.



Cleaning pulverized-fuel bins requires extreme caution to avoid fires and explosions. Trouble from moist pulverized coal sticking to the sides of a concrete bunker can sometimes be reduced by an insulating cement lining. Another procedure is to do no cleaning, but seal the bunker when not in use. An air-water spray filling the bunker with mist is another precaution sometimes found effective. Overheated coal in full bunkers reveals itself by odor; visual inspection every hour, emptying the bunker to the burners before adding more coal, and smothering the fire by closing the bunker vent are suggested.

## Gaseous Fuels

MOST IMPORTANT GASEOUS FUEL is natural gas, with coke-oven, blast-furnace, producer, and manufactured gas finding occasional use. Simplicity marks gas-handling systems, comprising pipe and valves mainly, and attention centers on designing for safety in operation.

The illustration shows schematically the piping connections between a gas main and five burners on a single boiler. Two sets of reducing valves drop pressure from 40 lb in the main to 10 lb at the control valve. Actual arrangement of piping in any individual plant depends, of course, on local conditions, such as kind and condition of gas, pressure, source of supply, and method of control.

Improper starting is probably the most frequent cause of explosions in gas-fired boilers and numerous arrangements have been devised to prevent such occurrences. The interlocking controls of the plant illustrated are so complete that study of the hookup will give a good idea of the way safety can be built into a gas-handling system.

### Starting Procedure

Furnace should be clear of gas when burners are started, so forced- and induced-draft fans are run for about 5 minutes to scavenge the furnace. Main control valve is electrically interlocked with induced-draft fan; fan must be running before valve can open. If valve is open and power fails, it closes automatically.

Each burner has an independent starting and protective system, featuring interlocked manually operated and electrically operated valves, a time-limit ignition switch, and a Protectoglow tube. After draft fans are running and furnace is scavenged, and with burner hand-operated valve closed, the starting procedure is:

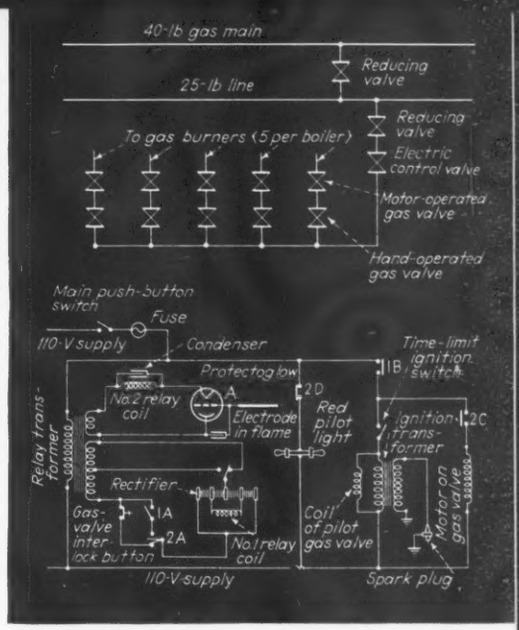
Main control valve is opened until it can be regulated automatically, but is left on manual control. Closing the main switch energizes circuits and red pilot lights indicate that burner is not in service. The time-limit ignition switch on each burner starts the pilot flame, which makes contact with the Protectoglow electrode. While this contact is maintained, the interlock which prevents opening the electrically-operated valve unless the hand-operated valve is closed, is shunted out. Contact between flame and electrode also causes the electrically operated valve to open automatically, and opening the hand-operated valve starts the burner flame, which also makes contact with the Protectoglow electrode. Three minutes after starting, the ignition switch opens automatically, cutting out the no longer needed pilot flame. The red pilot lights go out, indicating that the burner is operating.

If gas fails and the flame is extinguished, the contact with the Protectoglow electrode is broken, which closes the electrically-operated valve. Red pilot lights indicate burner is out of service. The interlock between the electrically-operated valve and the hand-operated valve comes into action, the pilot flame cannot be started again until the hand-operated valve is closed. Since the main control valve is interlocked with the induced-draft fan motor, if the fan stops this valve shuts down, followed by the electrically-operated valve at the burner. Two valves thus guard against leakage into the boiler; and before the burners can be started again, the hand valves must be closed.

In some plants where two valves are used in the gas-supply line, a bleeder or tell-tale valve is installed between to detect leakage. Gas leakage into boilers not in service is a serious menace and in addition to preventive devices such as those described in preceding paragraphs, and careful scavenging before firing, constant vigilance and maintenance is essential.

Gas from coke ovens, blast furnaces, or producers, and, in many cases, natural gas also, contains dirt and impurities. Where concentration is appreciable, cleaning is customary. Cleaners resemble those for flue gas, and may be wet, or dry, and if dry, may be mechanical or electrostatic. Wet cleaners are simple and effective, but bring corrosion problems and lose heat of gas, if taken directly from oven or furnace. Dry units are more complex and expensive but do not lower gas temperature or decrease heat input to boiler.

Occasionally, blast-furnace or similar gas is burned just as it comes from the furnace; heavy concentration of unburnable dust requires special attention to soot and slag removal and




Piping diagram, and electrical hookup for gas-burner protective system

may require provision for flue-gas cleaning if stack discharge is likely to become a nuisance.

Gas-supply pressures vary widely—in most cases pressure is considerably less than the 40 lb of the system shown in the illustration. Where supply pressure is extremely low, boosters may be required. These turbo-blowers may be turbine or motor driven.

Gas piping resembles other low-pressure piping except for importance of tight joints. Welding is commonly resorted to for tightness.

## Liquid Fuels

IN POWER PLANTS, liquid fuel means heavy oil. Heavy-oil handling systems vary widely in layout but all include storage tanks, strainers, pumps, preheaters, pressure regulators, and piping to tie the elements together. The illustration shows, schematically, a typical system.

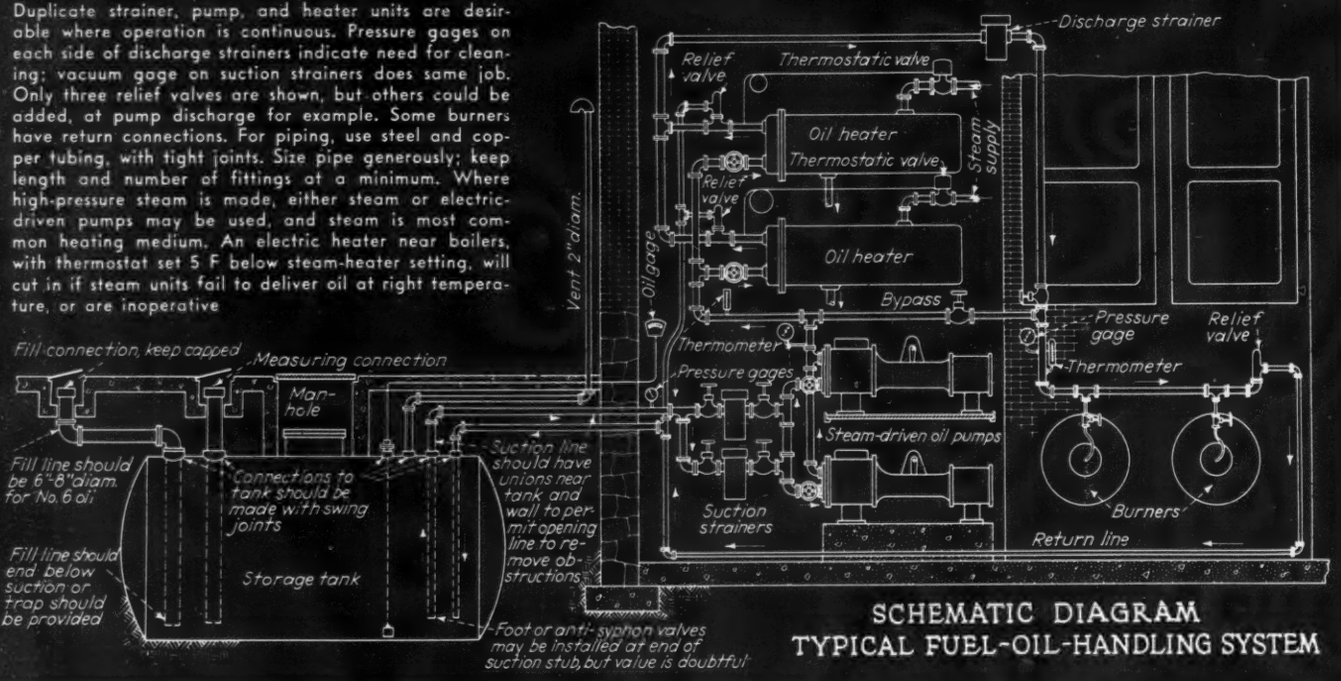
Tank size depends on method and frequency of delivery and rate of use. Tank should be larger than usual shipping unit and capable of holding a heavy week's supply. Excess capacity allows stocking up when prices are down; savings may pay additional investment.

Most tanks are of welded steel plate, although concrete is occasionally used; essential requirement is tightness and durability. National Board of Fire Underwriters publishes recommendations covering design and construction.

According to the NBFU, underground tanks should be at least 2 ft below grade with 1 ft of backfill above, topped by a 4-in. or thicker concrete slab extending 1 ft beyond tank in all directions. Sandy soil allows drainage; cinders or filled land will give trouble from acid corrosion. Anchor tank to heavy slab

**NOTES**

Duplicate strainer, pump, and heater units are desirable where operation is continuous. Pressure gages on each side of discharge strainers indicate need for cleaning; vacuum gage on suction strainers does same job. Only three relief valves are shown, but others could be added, at pump discharge for example. Some burners have return connections. For piping, use steel and copper tubing, with tight joints. Size pipe generously; keep length and number of fittings at a minimum. Where high-pressure steam is made, either steam or electric-driven pumps may be used, and steam is most common heating medium. An electric heater near boilers, with thermostat set 5 F below steam-heater setting, will cut in if steam units fail to deliver oil at right temperature, or are inoperative




SCHEMATIC DIAGRAM
TYPICAL FUEL-OIL-HANDLING SYSTEM

to prevent floating if ground water is likely to rise.

Tanks inside buildings, if over 60 gal., must be on lowest level, and at least 7 ft from boiler or fire, if unenclosed. If over 275 gal. singly, or 550 gal. total, tanks must be enclosed in 6-in. concrete or 8-in. brick walls rising to within 1 ft of ceiling, and bonded to floor. Space between tank and walls and ceiling must be filled with sand or earth, and if ceiling is not fire-resistant, a 5-in. concrete slab is required on top. In ordinary or fire-resistive buildings, tanks must not exceed 15,000 gal., but if tank room is isolated and fire resistant, tanks may run up to 25,000 gal. singly, or 50,000 gal. total.

## Tank Piping

Tanks for heavy oil need cleaning at least once a year; a manhole should be provided for access. Danger from fumes can be avoided by thorough ventilation before entering. Fill pipes should be large for quick filling, and must terminate outside the building at least 5 ft from any opening on same or lower level. Vents should be large in proportion and drain toward tank; they must terminate outside and more than 2 ft from any opening. Weatherproof heads protect vent opening against clogging. Permit no connection between vent and any other pipe; be sure vent terminates above fill opening. Suction and return lines are sized for expected flows; should clear bottom of tank by several inches to allow settlings to accumulate.

Stored oil can be heated, where necessary, by steam or hot water coils or by hot oil returned from the system. A helical coil around the suction is preferred, but tubes may be placed in the tank bottom. Use of steam requires a reliable means of removing condensate from coils. If hot oil is returned, return and suction stubs should be close together. Temperature near suction should not exceed about 100 F.

Changes in tank level may be gaged by measuring stick, gage glass, float gage, or hydrostatic gage. Gage glasses are forbidden by NBFU on inside tanks, because of fire hazard. Float gages are not accurate enough for figuring consumption or checking deliveries. Hydrostatic gages are more accurate (good to 1% if properly installed and maintained) and give remote readings. They must be calibrated for temperature and viscosity. Bulged sides, settling, or inexact tank dimensions may upset measurements.

Strainers may be perforated metal or wire mesh depending on oil weight and quantity handled; should protect equipment ahead without restricting flow unnecessarily. Minimum for good operation is a strainer on pump suction; it is preferable to add another close to burners.

Pumps for handling oil may be reciprocating or gear, and resemble pumps for general service in most respects (see *Power Pumping,* June, 1938). Steam drive is preferred in plants where high-pressure steam is available; steam and motor drives may be combined for flexibility. Standard texts explain calculating pump and piping sizes.

In most cases, desired oil pressure is maintained by pressure-relief valves. If single valve is used, it should be as close to the burners as possible. Often two or more valves are used (see sketch). Excess oil (hot) returns to storage tank.

Heating keeps heavy oils at proper handling viscosity, reducing pumping power and pump wear, and also improves combustion by accelerating reaction and improving atomization and mixing. Each oil has its own temperature-viscosity relationship, appearing as a straight line when plotted on log paper.

## Oil Heaters

Steam, hot water, or electricity may be used as heating medium. Steam, in shell-and-tube heaters with straight tubes, is commonly employed in power-plant preheating. Heater tubes should be accessible for regular cleaning, and heaters should be examined at intervals for leaks between steam and oil passages. Friction loss should be low and heating surface ample for both oil to be burned and oil to return to storage tank. Relief valves protect in case oil flow stops with steam left on. Steam units are controlled by a thermostatic valve in the steam line, hot water heaters by regulation of the circulating pump.

Electric heaters may be used as sole preheater, but common use is as auxiliary. Approximately 0.1 kwhr will raise 100 gal. of oil 1 F. Control is thermostatic, through relay and switch.

Manifold heaters (usually steam) are sometimes applied to long suction lines.

Before designing or installing systems for either gaseous or liquid fuels, be sure to study recommendations of the National Board of Fire Underwriters, and to check city codes and ordinances, which usually impose special restrictions. Remember that in both design and construction, safety is a first consideration.

# Turbine with Two Lives

*New unit operates from present boilers; adding a 575-lb element will make the turbine fit the changed picture when boiler plant swings to high pressure*

By W D DUNBAR
*Chief Engineer, Commonwealth Ice & Cold Storage Co*

CHANGES in equipment, recently made and planned, provide for present and future power, refrigeration and heating requirements of the Commonwealth Ice & Cold Storage Co. Flexibility of the steam turbine in meeting complicated heat-balance conditions and in permitting improvements in equipment and heat cycle has played an important role.

In 1914, a fish-freezer, cold-storage and 220-ton ice-making plant was built to supplement the new fish-packing and handling plant on the pier at the Foot of D Street, South Boston, Mass. It included four 2-drum water-tube boilers (3000 sq ft), each with 3-retort Taylor stokers and Foster superheaters, to supply steam at 175 lb g and 480 F; three single-cylinder Lentz 4-valve engines directly connected to 3-phase, 60-cycle alternators, each rated 180 kva at 220 volts, to supply current for lighting the entire pier, for the cold-storage system, for pumps handling cooling water and brine to stores and freezer, and electric freight and ice elevators. Also, four 200-ton, vertical, duplex ammonia compressors each driven by a Lentz 4-valve, cross-compound steam engine.

Piping of the generating units was so arranged that they could be operated either condensing or not, at will, while the compressor engines were fitted with an auxiliary exhaust line so that, by removing the low-pressure connecting rod and manipulating certain valves, the exhaust could be used for heating, which consumed practically all exhaust steam incidental to carrying the refrigeration load in winter.

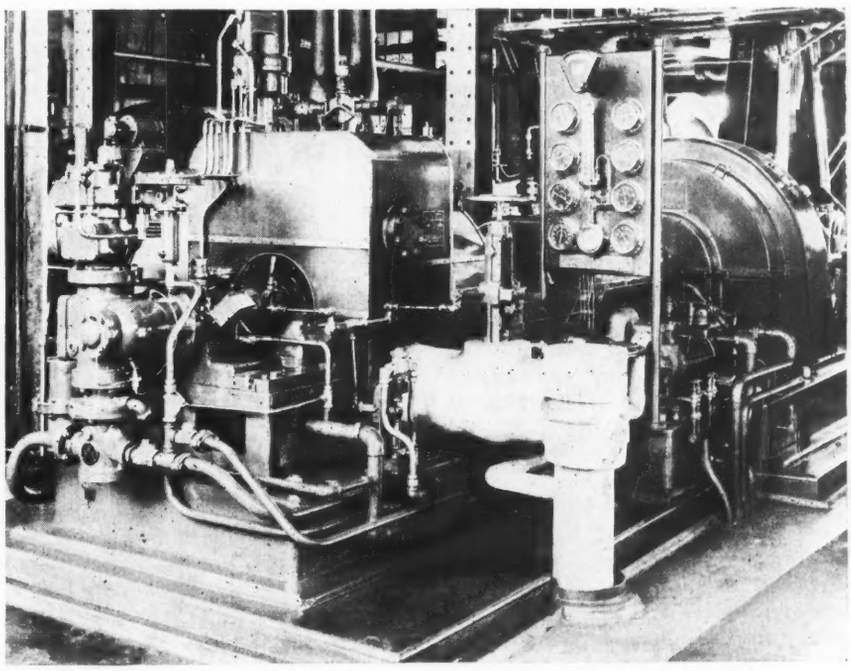
### Anticipated Load Growth

Although when originally built, capacity of the plant was much in excess of the load, larger seasonal quantities of merchandise in storage and the introduction of the quick-freezing process, together with greater demands on the ice-making equipment, finally led the company's engineers to make a comprehensive survey of past and probable future requirements in order that intelligent plans might be prepared for carrying the anticipated increased loads economically.

Up to 1935, all electrical power had been supplied by the three Lentz 4-valve engines just mentioned and by a 300-kw turbine-generator, but in that year it was decided to replace one of the steam-engine units with a larger turbine unit. After studying the economies obtainable with high-pressure superheated steam, modern high-pressure boiler and turbine equipment was selected as the ultimate goal. With this in view, plans were drawn for a turbine which could be operated from the present boiler plant, but so designed that it could be changed over to high-pressure steam when the boiler plant would be rebuilt in the future.

The casing for the new turbine, built by De Laval Steam Turbine Co provides for three separate elements, a 575-lb admission element to be inserted in the future when steam is available at that pressure, a 175-lb element, and a 5-lb element exhausting to condenser. The six stages now installed receive steam at 175 lb g with 100-F superheat, from the present boilers and exhaust to a 28-in. vacuum, steam for heating purposes being extracted ahead of the last stage at 5 lb g.

Extraction pressure is controlled automatically by a pressure governor regulating the readmission of steam to the low-pressure element of the turbine. When the 575-lb wheel is added ahead of the present first stage to convert the turbine to seven stages, high-pressure steam will be admitted through a nozzle now blanked-off and will be controlled by an added set of admission valves, while the multiport valves now controlled by the governor for admission of 175-lb steam will be retained for the readmission to



**Putting a high-pressure element in space provided in the casing, will make this turbine a vital part of future modernized plant**

the turbine of the unused part of the steam extracted at that pressure for the operation of the ammonia compressors.

With the added high-pressure wheel and high-pressure inlet control parts, the unit will then become a high-pressure, double-extraction condensing turbine receiving steam at 575 lb g with 172-F superheat, supplying 175-lb steam with 100-F superheat and 5-lb saturated steam, and exhausting more or less steam to condenser as required by varying load conditions. It is expected, however, that very little steam will be sent to condenser at any time, since expansion in the turbine of the steam bled at the two extraction pressures will probably be sufficient at all seasons to develop, with good thermal efficiency, all electrical power required. In winter a somewhat larger quantity of low-pressure steam will be extracted for heating and a minimum quantity of high-pressure steam for use in the ammonia compressors.

## Performance

The accompanying tabulations, showing total steam consumption, electrical load and steam bled at different seasons with the present initial steam conditions of 175 lb and with planned future steam conditions of 575 lb, are based upon the predicted electrical loads and extracted steam flows as given in the purchaser's specifications and upon performance curves prepared by the designers of the turbine. Shop tests made with, or corrected to, steam admission at 175 lb gage and 100-F superheat and with 27-in. vacuum, and field tests under similar steam conditions and at vacuums of 27, 28 and 28.45 in., show total steam consumptions slightly less than those given in the tables.

Governing of the turbine provides for holding constant speed and, at the same time, constant pressure of extracted steam, at either one bleed point as at present, or at two bleed points eventually. Steam admission is controlled by oil-cylinder-actuated valves, oil pressure being admitted to or released from the cylinders by pilot valves acted upon by a flyball governor and by pressure governors. The one pressure governor now installed responds to pressure at the 5-lb extraction point, while the one to be added will respond to pressure at the 175-lb point.

Without going into mechanical details, the operation of this multiple control may be understood by following through a sequence of events initiated by given conditions. Suppose, for example, that sufficient power is not being developed to carry the load. The speed will tend to fall, whereupon the speed governor will modify the oil

**PRESENT CONDITIONS**

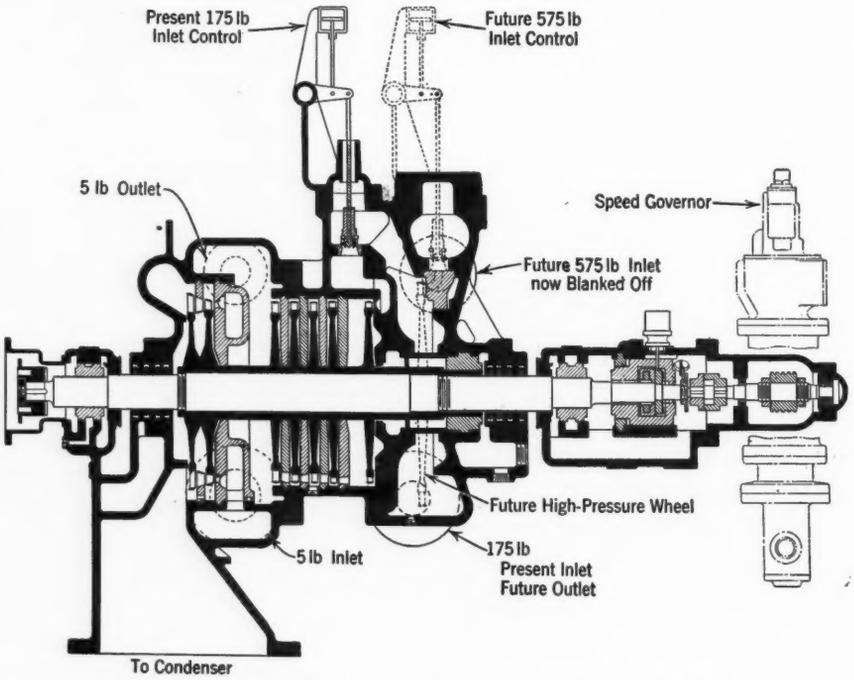
**175-lb g initial pressure, with 100-F superheat, bleeding at 5 lb g and with 27 in. vacuum**

| *Month* | *Load kw* | *Total Steam lb per hr* | *5-lb Steam Bled lb per hr* | *Steam to Cond. lb per hr* |
|---|---|---|---|---|
| Jan. | 300 | 9700 | 9400 | 300 |
| Feb. | 300 | 9700 | 9400 | 300 |
| March | 350 | 10,350 | 9000 | 1350 |
| April | 375 | 10,100 | 7500 | 2600 |
| May | 400 | 9450 | 5400 | 4050 |
| June | 410 | 9000 | 3700 | 5300 |
| July | 410 | 8600 | 3000 | 5600 |
| Aug. | 410 | 8600 | 3000 | 5600 |
| Sept. | 400 | 9000 | 4500 | 4500 |
| Oct. | 375 | 9400 | 6000 | 3400 |
| Nov. | 350 | 9900 | 8000 | 1900 |
| Dec. | 310 | 9500 | 8500 | 1000 |

pressure to the operating cylinder which controls the first steam admission, which at present is through the group of valves at the 175-lb pressure point, but eventually will be through valves to be added to control the 575-lb steam.

More steam admitted to the first turbine wheel or wheels will produce more power, but it will also tend to raise the steam pressure at the bleed point or points, which, in turn, will cause the governor responsive to extraction pressure to open wider the valve which releases steam to succeeding stages of the turbine. Unless made slow-acting, a simple chain of governing actions of this type has a tendency to set up surging or hunting, which, however, can be, and is provided against by suitable compensating actions.

In the present instance, this is accomplished by making each governing action automatically, but only temporarily, self-limiting and, further, by cross compensation effected by a linkage, which, when the speed governor opens the initial steam-admission valve wider, simultaneously also tends to open wider the readmission valves at the bleed point or points. In this way the increased flow of steam required to meet the increased demand for power is allowed to flow down through all turbine stages instead of building up pressure at the bleed point or points. The compensating piston is bypassed by an adjustable leak, so that the compensating action


Present 175 lb Inlet Control
Future 575 lb Inlet Control
5 lb Outlet
Speed Governor
Future 575 lb Inlet now Blanked Off
Future High-Pressure Wheel
5 lb Inlet
175 lb Present Inlet Future Outlet
To Condenser

**Section through turbine shows how 575-lb element will be added**

ANTICIPATED FUTURE CONDITIONS

**575-lb g initial pressure, 172-F superheat, bleeding at 175 lb and 5 lb and with 27 in. vacuum**

| Month | Load kw | Total Steam lb per hr | 175-lb Steam Bled lb per hr | 5-lb Steam Bled lb per hr | Steam to Cond. lb per hr |
|---|---|---|---|---|---|
| Jan. | 420 | 11,000 | 3,050 | 7950 | ... |
| Feb. | 456 | 12,200 | 4,275 | 7925 | ... |
| March | 536 | 16,200 | 9,050 | 7200 | ... |
| April | 595 | 18,750 | 13,200 | 5550 | ... |
| May | 664 | 19,500 | 14,400 | 5100 | ... |
| June | 676 | 21,000 | 16,750 | 3700 | 550 |
| July | 690 | 22,750 | 19,400 | 3000 | 350 |
| Aug. | 690 | 24,000 | 21,490 | 2510 | ... |
| Sept. | 670 | 22,750 | 19,550 | 3200 | ... |
| Oct. | 620 | 21,000 | 16,880 | 4120 | ... |
| Nov. | 564 | 16,000 | 9,100 | 6900 | ... |
| Dec. | 484 | 12,600 | 4,330 | 7270 | ... |

will be only temporary and the pressure-responsive governor will gradually resume sole control of its valve.

Similarly, consider what happens when the amount of steam required at a bleed point is increased without at the same time a demand for increased power. In order to dam up pressure, the pressure-responsive governor will tend to close the valve readmitting steam to stages of the turbine following this point. However, if this were allowed to happen without compensating action, it would reduce the amount of power generated and the turbine would slow down. To prevent this, the pressure governor, when it throttles the readmission of steam to the lower stages of the turbine, at the same time acts upon a compensator which tends to open the higher-pressure admission valves, thus providing for increased steam admission and permitting increased extraction without decreased power production.

The speed and the pressures to be held at the bleed points are manually adjustable. In addition to the speed governor there is an independent overspeed trip-out which shuts off all steam.

The 500-kw alternator is driven from the turbine through a DeLaval double-helical reduction gear at 1200 rpm. Since much dust and dirt accumulate at the point where the generator is, the end bells are completely enclosed in air ducts, with a surface air cooler.

Since it was impossible to predetermine just when the high-pressure boiler and high-pressure turbine parts will be added, the condenser initially installed has been made of a size ample to condense the considerable quantity of steam exhausted under present operating conditions. When the high-pressure equipment is added, there will be less steam to condense, but the condenser is provided with a large deaerating hotwell for eliminating oxygen from feedwater supplied to the high-pressure boilers.

There are two motor-driven centrifugal hotwell pumps, but ordinarily only one is in operation. However, a pressure control will start the second pump automatically should there be any failure of the one running to deliver water, a transfer switch providing for changing the leading pump from day to day. The duplicate circulating pumps are likewise fitted with a temperature control, consisting of a mercoid switch actuated by a thermal element contained within the shell of the condenser. This will start up the idle pump should the temperature in the condenser reach 125 F, which would indicate a drop in condenser vacuum, the added pump continuing in operation until cut out by hand. In this case, also, a transfer switch provides for changing the leading pump from time to time. The jet air pumps are fitted with inter- and after-surface condensers.

✦ ✦ ✦

# Questions for Boiler-Room Engineers

**By Harry M Spring**

THESE QUESTIONS are similar to those asked in some of the better-arranged state examinations for licenses to operate steam boilers. Use them as an aid in interviewing and selecting power-plant employees, and as a review of important features of boiler-room operating practice. From time to time POWER will publish additional questions of this type.

*Q—A safety valve chatters. What is a common cause and remedy?*

A—Insufficient blowback; increasing it would remedy the condition.

*Q—What is another cause of safety valve chattering?*

A—Too much friction and pressure drop in the connecting nipple or in the escape pipe.

*Q—What should the minimum blowback of a safety valve be?*

A—Not less than 2% for valves set for 100—300 lb; not less than 2 lb for valves set at lower pressures.

*Q—How would you go about adjusting the blowback, except in emergencies?*

A—The blowback is set and sealed by the manufacturer. It should be adjusted only by his representative.

*Q—Which butt strap is narrower and why?*

A—The outside strap is equal to or narrower than the inside strap. This brings the caulking edge adjacent to a row of comparatively closely pitched rivets so as not to spring the strap, and insures a tight joint.

*Q—How would you tell if a staybolt in a firebox boiler was broken?*

A—Staybolts with telltale holes usually show leakage when cracked halfway through. If staybolts are not flexible, they may be sounded by striking with a hammer, and the broken one detected by lack of a ringing thud. Flexible staybolts seldom break, but if they do, the break may be detected by removing the cap of the ball socket, and twisting the ball with a heavy screwdriver.

*Q—How would you repair a broken staybolt?*

A—It should not be repaired but renewed.

*Q—What are five reasons which might cause an oil burner to suddenly lose its ignition on full load?*

A—(1) A slug of water in the oil, (2) stoppage of oil pump, (3) air pocket in oil flow, (4) obstruction in oil line or strainer, (5) no oil in storage tank.

# Motor Controllers Lock-Stepped

*Ingenious control system interlocks draft-fan-motor controllers so that they stay in step when operated from the automatic combustion-control system*

By H W BETZLER
*Technical Development & Research Dept*
*Consolidated Edison Co of N. Y., Inc*

SHORTLY after putting in automatic combustion control on boiler No. 5 in our Kips Bay boiler plant, we found we needed a control that would insure synchronous movement of draft-fan-motor controllers. This boiler has two induced-draft and two forced-draft fans, each driven by a 2300-volt wound-rotor induction motor, speed of which is controlled by a 14-step, General Electric pilot-motor-operated cam switch or drum controller. Pilot motors are energized in a forward or reverse direction through reversing contactors by remote pushbuttons under supervision of the boiler operator. Each pilot motor drives its controller through gearing in the proper direction to obtain desired change of fan speed.

After installing automatic combustion control, satisfactory fan-speed regulation was complicated, because dual fans were being used for forced and induced draft on each boiler. The two fans in each group normally operate in parallel on the gas circuit and it is important to keep gas flow balanced between them at all times.

## Control Diagram

Fig. 1 shows a schematic diagram of the individual pilot-controller connections as they existed before the automatic combustion control was installed. For the sake of simplicity, only essential contacts for the control are shown. Notice the dynamic braking of the pilot motor, which is necessary to prevent over-travel of the controller. Dynamic braking was put in to replace the solenoid-operated mechanical brakes which were unsatisfactory under our service conditions. Another difficulty was that holding either pushbutton depressed for too long caused the controller to run through more than one speed step. This occasionally caused fan motors to be tripped out on overload because they were accelerated too rapidly.

Originally, the forced-draft fan-speed control was tied in with the automatic combustion-control system by a 2-pole relay which simultaneously shunted the "speed-up" pushbuttons on each forced-draft controller. A similar relay was used for shunting the "slow-down" pushbuttons. These relays were operated from the combustion control in response to furnace-requirements and were set so that impulses to the fan controllers lasted just long enough to cause them to travel one step. Induced-draft-fan control was an exact duplicate and operated from another set of similar relays according to induced-draft requirements.

For a short time operation was satisfactory; then, the controllers of each pair of fans would go out of step, which would unbalance fan loading. Investigation showed that one controller of a pair would frequently run up or down more than one step while the other was running one step. This was a result of service conditions under which the series-wound pilot motors worked, and which affected the speed of contact travel. We found these conditions to be extremely variable because of differences in contact pressure during drum travel, variations in controller-mechanism conditions, etc. All these factors were recognized as difficult to control without excessive maintenance on both timing relays and controllers.

We finally decided to develop a way of definitely limiting controller travel to a change of one step in either direction, regardless of initial-impulse duration. Then, by making the impulse long enough to insure the slowest controller completing a change of one step, both controllers would remain in step. Fig. 2 is a schematic diagram showing the connections for doing this. Operation is as follows:

Pressing pushbotton $FPB_1$ closes a circuit from the positive line through normally closed pushbutton $SPB_2$, interrupting-relay $IR_2$, fast-pilot-motor-contactor coil $FC$, slow-down pilot-motor contact $SC_3$ and coil of dynamic-braking relay $DBR$ to negative. This picks up the armatures of relays $FC$ and $DBR$. The pilot motor is energized through contact $DBR_1$ closed to the left and through contact $FC_1$ with its field in circuit to accelerate the fan motor. Movement of the controller makes contact between stationary contact $PS$ and the positioning segment. This establishes a maintaining circuit from positive line

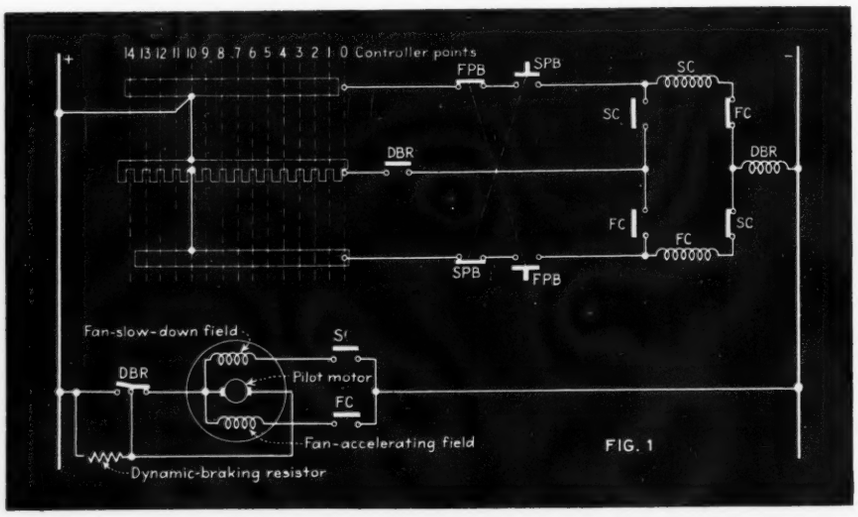



**Fig. 1—Schematic diagram of original forced-draft-fan motor control connections**

through $PS$, $DBR_2$, the 3000-ohm resistor, $FC_2$, to $FC$ and through contact $SC_3$ and coil $DBR$. At the same time, interrupting-relay coil $IR_p$ is energized from $DBR_2$ through $FC_4$ which opens contacts $IR_1$ and $IR_2$ and closes $IR_3$ and $IR_4$. Contacts $IR_1$ and $IR_2$ break the circuit from $FPB_1$ to contactor coils $FC$ and $DBR$. At the same time, the circuit from $FPB_1$ is closed through $IR_3$ to energize relay coil $IR_h$. Pushbutton $FPB_1$ thus is cut out of the pilot-motor control circuit and remains so until coil $IR_h$ is de-energized. This will take place only after $FPB_1$ is released.

When the controller reaches the next operating point, contact between $PS$ and the first positioning segment is broken, thus opening the maintaining circuit to $FC$ and $DBR$. Since $FC$ has a time-delay drop-out, excitation of the pilot-motor speed-up field is maintained from positive through the

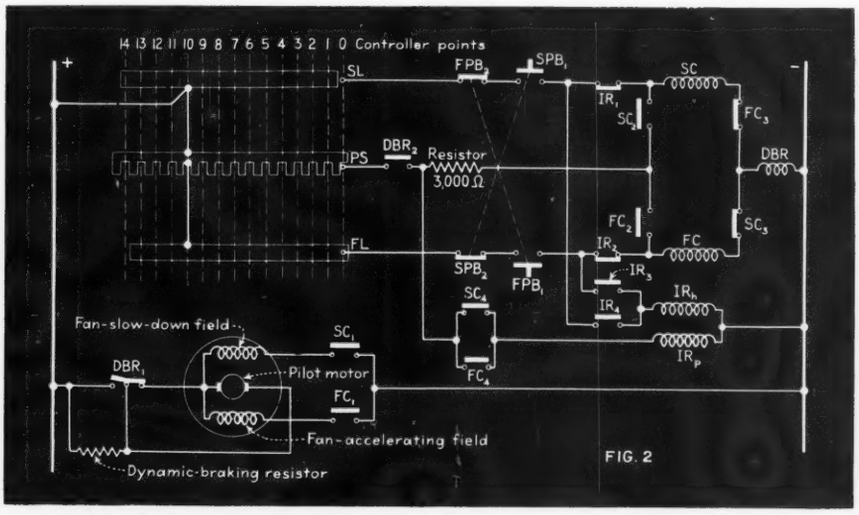



**Fig. 2—Schematic diagram of forced-draft-fan motor control connection after change to one-step operation**

***SL*—Fan slow-down limit switch. *FL*—Fan speed-up limit switch. *PS*—Contact position switch. *SPB*—Fan slow-down pushbutton. *FPB*—Fan speed-up pushbutton. *SC*—Fan slow-down pilot-motor contactor (Instant pick-up and delay drop out). *FC*—Fan-accelerating pilot-motor contactor (Instant pick-up and delay drop out). *DBR*—Dynamic-braking relay (Instant pick-up and drop-out). *IR*—Interrupting relay. *IRP*—Interrupting-relay closing coil. *IRH*—Interrupting-relay holding coil.**

braking resistor, $DBR_1$ back contact closed to the right, and $FC_1$ to negative. The pilot-motor armature is at the same time effectively short-circuited by $DBR_1$ contact. Dynamic braking action of the armature arrests any further travel or coasting of the controller. Stopping of the controller is finally followed by time-delay relay $FC$ dropping out at the expiration of its delay period, which removes excitation from the pilot-motor field. Even though pushbutton $FPB_1$ is held closed up to this time, no further movement of the controller will take place as a result of relay $IR$ being held in and contacts $IR_1$ and $IR_2$ being held open.

So far, controller motion in one direction only has been explained. Opposite direction of the controller is exactly the same, but functioning through the $SC$ relay instead of $FC$.

For the installation at Kips Bay, which utilizes a 250-volt dc control supply, relay $IR$ was built up of two Cutler-Hammer series-323 contactors with their two armatures connected by a tie bar so that the contact action would be the same, regardless of which armature was closed. A C-H No. 72-22 coil $IR_p$ is used on one frame and a C-H No. 72-50 coil $IR_h$ is used on the other frame. The 3000-ohm resistor was needed in the circuit to limit the current through $IR_p$ so it would not pick up due to backfeed when $FC_2$ and $FC_4$ close. At the same time, this resistor has to pass enough current to maintain $FC$ and $DBR$ picked up when necessary. The relay $IR$ and 3000-ohm resistor were mounted on the pilot-motor contactor panels (GE type CR-6189-Y1), Fig. 3.

When completed, these panels were tested in the laboratory for a period equivalent to over 7 months continuous plant service. After satisfactorily passing these tests, the panels were installed and connected into the automatic combustion-control system. This was done by having one relay close two circuits, each of these circuits bridging the fast pushbutton $FPB_1$ of each of the forced-draft fans, when the demand existed for higher fan speed. Demand for lower fan speed

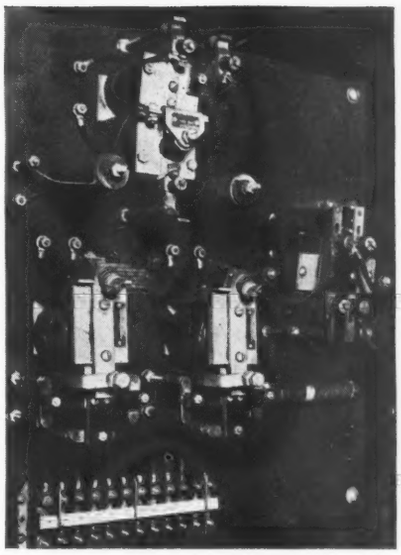


**Fig. 3—Controller pilot-motor contactor panel for one-step operation**

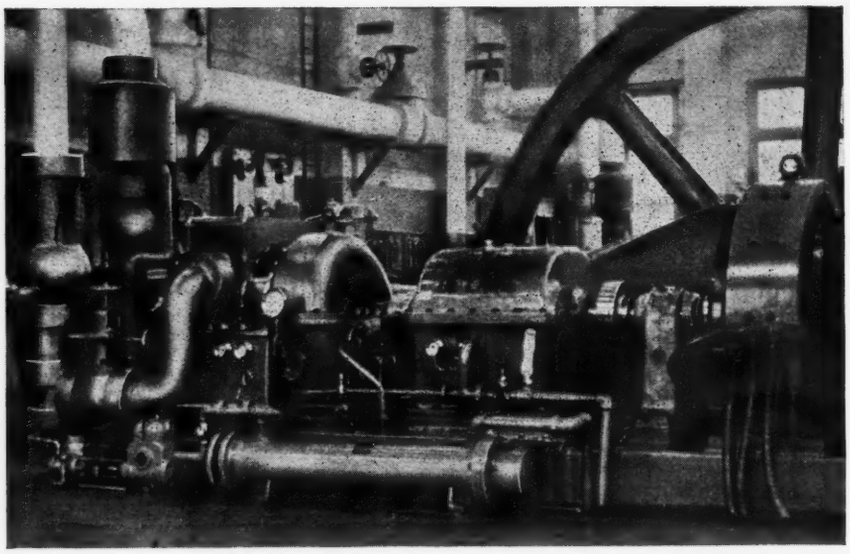
was satisfied with a similar relay bridging slow pushbutton, $SPB_1$ of the fans. These relays are time-delay drop-out type, delay periods being set at values that safely exceed the time taken for the slower controller to travel one-speed step.

This system provides a relatively simple method for operating electrically two or more pilot motor-driven drum controllers simultaneously from one control circuit and having the controllers keep in step with each other.

## Control Advantages

Such a control system gives in its application practically the same effect as a mechanical coupling between the controller shafts. In addition, it makes possible the operation of any individual controller from its own control station and its setting at any number of operating points above or below those of the others. This setting relation will then be maintained by the group until one of the controllers reaches its extreme limit of travel, beyond which point further operation of the group will tend to equalize the controller positions again.

The control has been in use for over three years at the Kips Bay Station, simultaneously controlling the speed of two 900-hp forced-draft fans on a 1,000,000-lb per hr steam generating unit. There has been no maintenance work of any kind done on the equipment comprising this control since its installation. Its ability to keep the positions of the controllers synchronized has been amply demonstrated and similar installations of this control to the two 1100-hp induced-draft fans of the same and other boilers will be made.



New condensing turbine in shadow of Allis-Chalmers Corliss engine flywheel

# Modernizing an Average-Size

*No sensational advances at this college plant—just an intelligent plan for making the best of old equipment and getting the most out of new investment*

By ROY A CLARK
*Operating Staff, Vassar College*

POWER DEVELOPMENTS at Vassar College, Poughkeepsie, N. Y., demonstrate again that the average-size plant can keep pace with power progress by intelligent engineering and operation. Nothing sensational was involved—just a step-by-step program of modernization based on making the best of existing equipment until engineering studies showed new units justified.

Steam for heating 66 campus buildings, including 24 faculty residences, academic and recreational buildings, and dormitories, is the principal product of the plant, which has a maximum steaming capacity of 180,000 lb per hr. Approximately 200,000 sq ft of radiation are supplied, of which 80,000 can be supplied by exhaust steam, an amount now limited by transmission difficulties due to small mains. When funds are available, these mains will be replaced with larger ones, and three additional buildings (26,000 sq ft radiation) will be added, bringing percentage of heating by exhaust to about 50%.

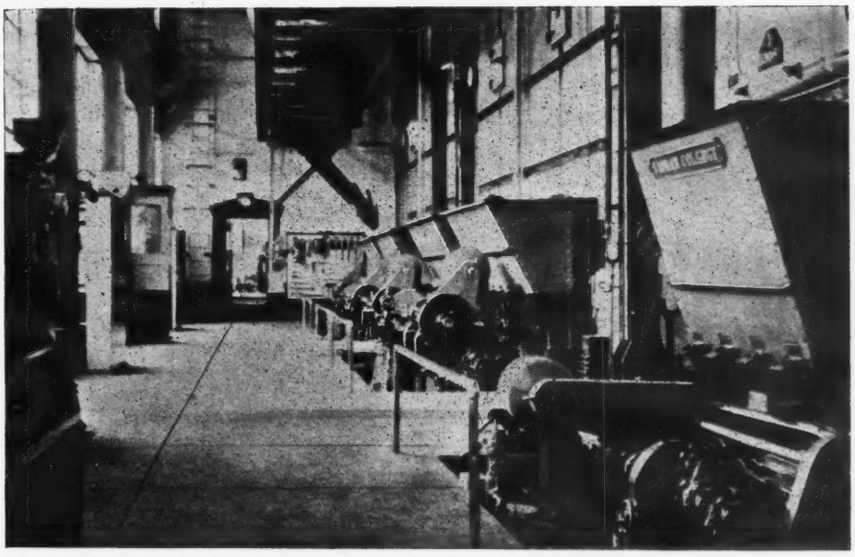
## Increasing Load

Faced with an increasing power load, rehabilitation of the engine room began in 1932 with the installation of a condensing turbine. Only other means of power generation at that time were three reciprocating engines operating at 5-lb backpressure, and in mild weather, and with heavy loads, exhaust from these units was in excess of heating requirements. During the summer it was all wasted, since sufficient exhaust for heating feedwater was available from auxiliaries. The condensing turbine thus added a means of efficient power generation for periods when exhaust was not needed.

This turbine is a 450-hp DeLaval, operating on dry saturated steam at 100 lb g, and with a vacuum of 28.5 in. Running at 6940 rpm, it drives a 1200-rpm, 250-volt dc Allis-Chalmers generator through a DeLaval double-helical reduction gear. This unit operates only when all buildings that can be heated by exhaust are on, and there is still some excess. This arrangement has been in effect for some time now, and practically no exhaust goes to atmosphere winter or summer.

Next step in the modernization program was the boiler room, and two 5672-sq ft Stirling units were installed in 1933, followed by two more in 1934. These replaced four B & W inclined water-tube boilers which had seen better days. The present boiler room comprises these new boilers and one older unit, used chiefly during summer months, and as standby. All boilers are designed for 200 lb g, but operate at 110 lb and 343 F. Each has a maximum steaming capacity of 40,000 lb per hr at 250% rating.

To better efficiency and foster intelligent operation, an unusually complete installation of controls and instruments was made. A master panel carries the steam-pressure-responsive master regulator which actuates fuel and air regulators mounted on control and meter panels for each boiler. Each boiler has an air-flow regulator and recorder, a steam-flow indicator and integrator, an exit-gas temperature recorder, and a 3-point draft gage connected to windbox, furnace, and uptake. Push-button control is provided at each panel so that the boiler may be switched on automatic or manual control or taken off the line.



The boiler room: old boiler at right, four new units beyond

# Plant

When on manual control, all functions can be controlled from the panel. In addition to the above, an indicating, recording, and integrating venturi meter is installed in the feed line, and each boiler is equipped with a thermo-hydraulic feedwater regulator.

Six-retort Taylor underfeed stokers, motor-driven, fire the boilers. Steam-engine auxiliary drive is provided in case of power interruption. Forced-draft equipment is proportioned to carry boilers to 250% rating; boiler design permits high-rating operation at little loss in efficiency. This firing equipment can handle a variety of coals with minor adjustments, maintaining about 13.5% $CO_2$ at normal load with 40% excess air, when steam-flow air-flow lines coincide.

Trucks deliver coal to a shed adjoining the boiler room, from a coal pocket owned by the college. A crane and scraper conveyor carry it to a 100-ton bunker in front of and above the boilers, from which it flows to a motor-driven larry equipped with Toledo scales for recording weight of feed to each boiler.

From main headers over the boilers, steam flows to prime movers and auxiliaries and through reducing valves to underground mains for distribution for building and hot-water heating, cooking and laundering. Exhaust from prime movers is piped to low-pressure underground mains. Welds connect most pipe lengths except at valves where flanges are used. In 1935, a new 14-in. header running to the engine room was erected. It is estimated that this will handle enough steam, with little pressure drop, to take care of any additional equipment bought during life of the header.

Condensation from the heating system drains to two receivers in the pump room, where four combined vacuum and water pumps, coupled in tandem to motors, lift it to open heaters. Heaters overflow to two outside storage tanks from which circulating pumps continually draw water and circulate it through heaters, assisting deaeration and keeping heaters filled. Heaters are supplied with exhaust steam from the feed-pump drives supplemented with high-pressure steam from a reducing valve. High quality of water available makes treatment unnecessary.

## Feed Pumps

Centrifugal feed pumps take suction from heaters or from storage tanks if heaters are out of service. Feed lines are in duplicate, and to further insure continuity, storage tanks are connected to a steam pump taking suction from a nearby creek. Two feed pumps are turbine driven, one motor driven; turbines are equipped with overspeed and excess-pressure governors.

Last major improvement was made in 1936, when a unit was installed to pinch hit when either engines or turbine are out for repairs. To fill this bill required a compromise unit capable of running either condensing or non-condensing. A 375-hp DeLaval running at 4300 rpm and geared to a 275-kw, 1200-rpm Allis-Chalmers generator replaced an old 75-kw unit which had been in service since the college first started generating power. The condenser on the first turbine serves this new machine when it operates condensing, and can handle both units (at 26.5 in.) when the total load does not exceed 500 kw.

Location of this condenser is unusual; it is some 30 ft from one turbine and 50 ft from the other. No trouble has been associated with this feature and a vacuum of 28.5 in. can be maintained at normal load.

Naturally, this compromise turbine unit is not as efficient in either condensing or non-condensing operation as a unit designed for one service or the other, but its availability allows minor repairs to be taken care of immediately, offsetting the possibility of much costlier work. Although there is some advantage in operating both turbines condensing at the same time, this is discouraged because of the decrease in efficiency suffered by both due to poorer vacuum, and because this was not the original intent. Installing this last turbine gives a supply of exhaust steam that can be adjusted to meet almost any weather condition, with ample available for additional buildings.

## Operation

Operating procedure gets close attention in this plant. A comprehensive log is maintained, and from this record, plant performance is checked daily. When the first turbine was installed in 1932, few of the operators were familiar with turbine operation. To remedy this, Mr Keene Richards, General Manager and Consulting Engineer of the college, gave a series of talks on the theory, operation, and maintenance of turbine-generator units. As a result, the transition was made smoothly and no troubles traceable to operating ignorance were encountered. Some corrosion of blades in the first stages was experienced but this has been kept to a minimum by careful boiler operation to insure delivery of moisture-free steam.

Tests made last August, by the operating staff, and with standard operating instruments, show boiler efficiency of about 77% and an evaporation of about 10.6 lb of steam per lb of coal. Fuel used in this 10-hr test had the following proximate analysis:

| | |
|---|---|
| Volatile | 35% |
| Fixed Carbon | 56% |
| Ash | 7% |
| Moisture | 2% |
| Btu (as fired) | 14,000 |
| Ash Fusion | 2550 F |

A typical flue-gas analysis showed 14% $CO_2$, 5.5% $O_2$, and about 0.4% CO; temperature ran about 575 F.

# Ins and Outs of Boiler Outage

*Costly unnecessary outages can often be eliminated by setting up and following a carefully worked out procedure for handling scheduled overhauls*

By S H COLEMAN

UNNECESSARY OUTAGE of steam-generating units can be avoided by paying more attention to equipment inspection before, during, and after periods of scheduled overhauling. Unless a rigid program of inspection and maintenance is set up and held to, some small defect may escape notice and cause outage long before the next scheduled shutdown. Outages cost money; eliminating preventable ones is an easy way to save power dollars.

As an illustration, the following outline of how to do the maintenance job, based in part on that used in a large industrial power plant, operating at 435 lb and 650 F, may prove helpful.

The shift engineer should supervise removing the boiler from service. If possible the chief engineer or master mechanic should check the shift engineer's maintenance survey.

Before removing the unit from service, the shift engineer should make a thorough external inspection, noting all visible defects on the maintenance check sheet. Internal troubles indicated by operating difficulties should be noted, and daily operating logs should be checked for forgotten troubles.

1. While boiler is still steaming at or near normal rating, operate all soot blowers several times.
2. Reduce load, take feedwater regulator out of service and stop fuel feed.
3. Shut off feedwater valves, taking care that water remains in sight above bottom of gage glass.
4. Stop primary air fan.
5. Stop forced- and induced-draft fans.
6. When steam pressure drops below main-header pressure, shut main stop valve.
7. Open superheater drain valves, and drain valve between main stop and non-return valve.
8. Close manual-closing device of non-return valve.
9. Take damper regulator out of service and close stack damper.
10. Blow down water columns, gage glasses, and feedwater regulator while there is still pressure on the boiler.
11. Open vent valves on steam drums when pressure drops to slightly above atmospheric.
12. When the setting is cool, empty the boiler through the blowoff valves.
13. Close blowoff and superheater drain valves.
14. Lock or otherwise safeguard main stop, main feed, and all blowoff valves. Pull disconnecting switches or lock steam valves of auxiliary equipment. Hang DANGER or OUT OF SERVICE tags on all switches or valves that are not to be operated while unit is off the line.

After boiler and setting are cool enough to enter safely, the shift engineer should release the unit to the master mechanic. Before proceeding further, the master mechanic checks all danger points to satisfy himself that they are protected. He will then:

1. Open all manhole covers.
2. Wash down all interior surfaces. While blowoff valves are open to drain out this water, blowoff valves of other units must be locked closed.
3. Clean gas-side surfaces of boiler, air preheater, and economizer. Scrape down water walls and remove all refuse from furnace and ash hoppers.
4. Remove designated handhole plates from water wall and ash pit screen headers to permit inspection.
5. Inspect the unit and its auxiliary equipment thoroughly, noting on the maintenance check sheet all items requiring attention. The Chief Engineer should check this inspection.
6. Proceed with repair work taking care that as far as practicable, work is done so that unit can be returned to service on short notice.
7. After all work has been completed and checked off on list, the master mechanic will close the drums and release the unit to the shift engineer for a hydrostatic test. If test is satisfactory, the shift engineer will ready the unit for service.

### Returning Boiler to Service

The shift engineer will:

1. Remove all DANGER or OUT OF SERVICE tags and inspect setting to see that all doors are closed, scaffolding and tools are out of the furnace, and that all men are clear.
2. Drain the boiler down until about 1 in. of water shows in the gage glass.
3. Introduce treatment chemicals.
4. Open all vent valves and close all drain valves.
5. See that soot-blower main stop valves are closed.
6. See that all feedwater valves are open up to the hand-control valve.
7. See that all auxiliary equipment is ready for service.
8. Drain water out of superheater and leave drain valves open.
9. Drain water out of steam line and close drain valve between main stop and non-return valves.
10. See that all valves to water columns and pressure gages are open.
11. See that water-column blowdown valves are closed.
12. Put damper regulator in service.
13. Start induced- and forced-draft fans and light fire, adjusting draft and combustion rates as necessary.
14. Note that pressure gages are operating.
15. Close all vents on boiler drums as soon as all non-condensible gases have been vented.
16. When pressure reaches 350 lb, open manual stop in non-return valve.
17. Blowdown feedwater regulator.
18. Blowdown water column and gage glasses.
19. See that drain valve between main stop and non-return is open.
20. Open main-stop-valve bypass valve, warm up steam lead, and blow out condensation.
21. Open the main stop valve and close the bypass.
22. Close the drain valve.
23. When the boiler cuts in, put feedwater regulator in service and close superheater drain valves.
24. Blowdown water columns and test safety valves.
25. Inspect the unit thoroughly and rectify any visible defects.
26. Put the flowmeter in service.

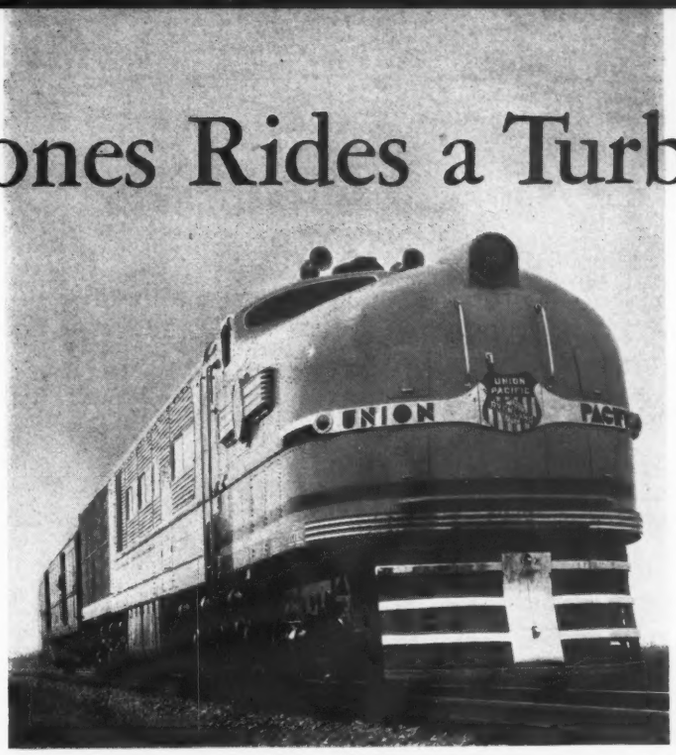
# Casey Jones Rides a Turbine

UNVEILED at the Erie, Pa., locomotive works of General Electric Co in December, was this country's first steam-electric locomotive, a complete power plant on wheels. And for the first time, a steam turbine rode the rails in a role other than that of providing freight revenue.

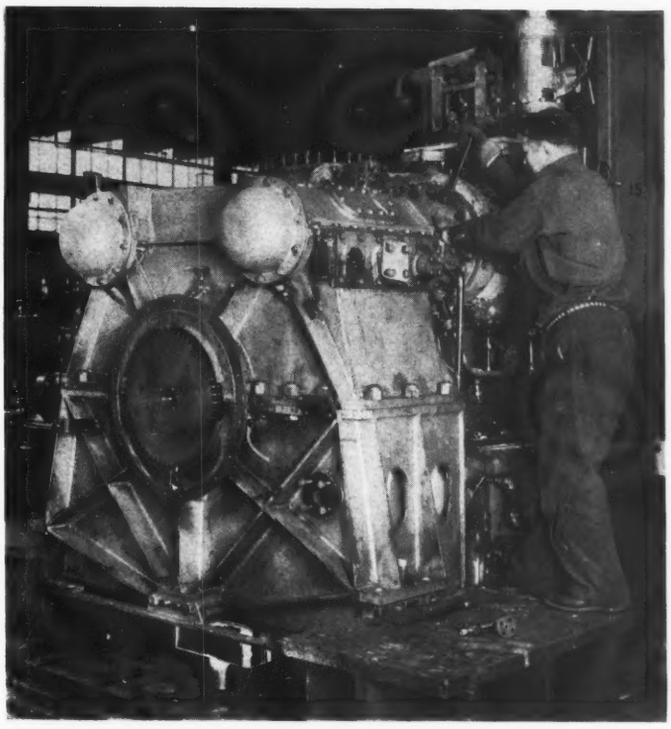
There are really two 2500-hp locomotives, but the plan is to operate them as a 5000-hp tandem unit over the mountainous route between Chicago and the West Coast. Each locomotive has a B & W, water-tube, forced-circulation "steammotive" boiler, incorporating a furnace, superheater, economizer, air preheater and burners for Bunker C oil, designed to furnish 45,000 lb of steam per hr at 1500 lb, 920 F. Steam, after passing through the turbines, goes to air-cooled condensers in the rear of the locomotive; condensate returns to the boiler.

The main turbine-generator set includes: (a) High- and low-pressure turbines. (b) A 2-armature dc generator, driven through a reducing gear from the turbine, to supply power to the traction motors. (c) 220-volt, 3-phase ac generator connected to main generator shaft through a flexible-disk coupling. This alternator furnishes power for train air conditioning, etc.

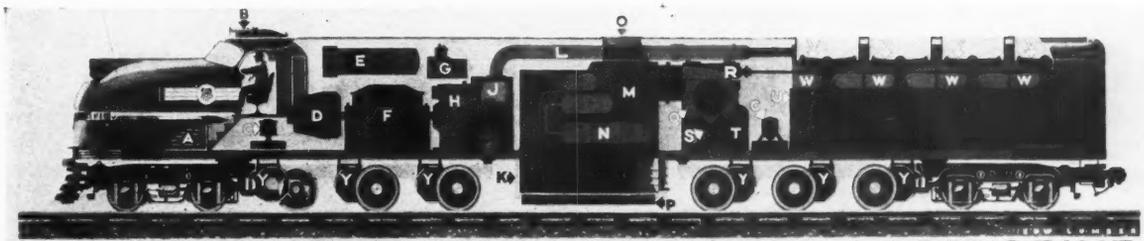
Over-all thermal efficiency from fuel to driving wheels is expected to be about 12%, compared to 6-8% for the standard steam locomotive and 23-25% of a diesel-electric unit. Fuel cost per gallon of the steam-electric locomotive will be much lower than that of the diesel-electric, and the former will cover longer distances without stops for water and fuel. The two locomotives are to be delivered this month to the Union Pacific.




One of the two 2500-hp steam-electric locomotives getting a workout on the test track at Erie, Pa. Total length 90 ft, 10 in.; height, 15 ft; maximum operating speed, 125 mph

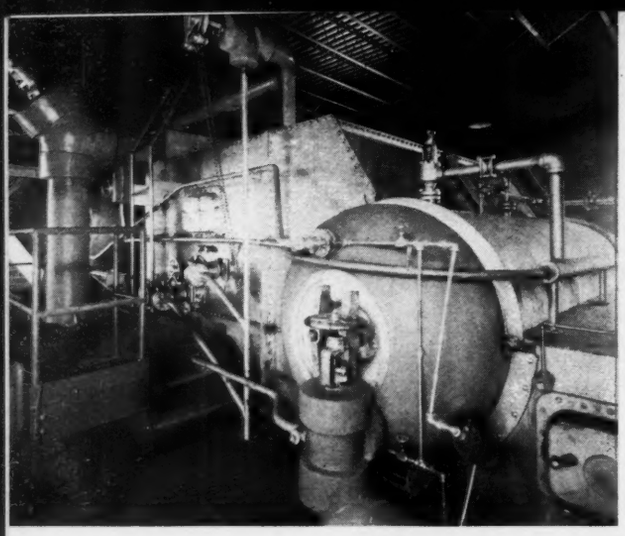


Turbine unit, from the gear end, gets final tightening-up before being put in the locomotive. Unit, consisting of high-and-low-pressure turbines, runs at 12,500 rpm, and through reducing gear, drives generator at about 1200 rpm



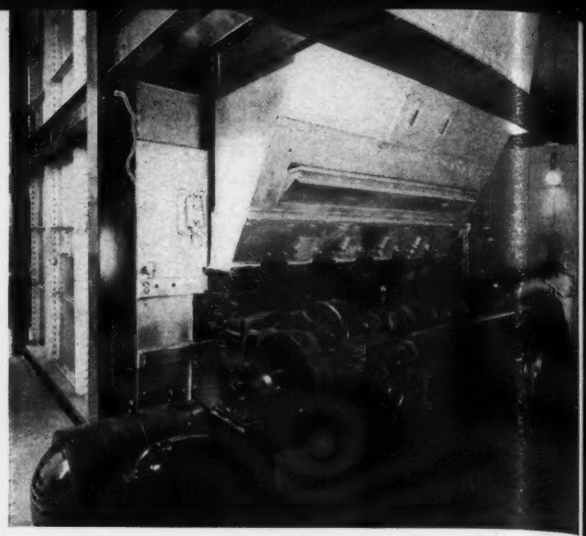

**UNION PACIFIC STEAM-ELECTRIC LOCOMOTIVE**

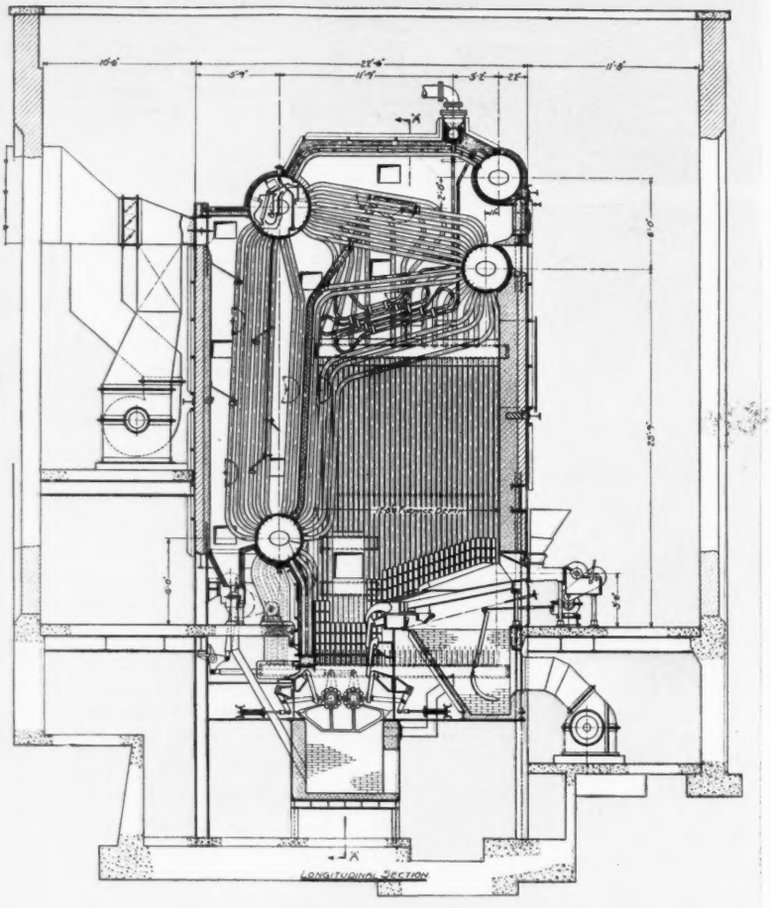
| | | | |
|---|---|---|---|
| **A** RAW WATER TANK | **G** AIR BRAKE COMPRESSOR | **N** FEED WATER HEATER | **T** BOILER AUX. SET TURBINE |
| **B** VERTICAL HEADLIGHT BEAM | **H** REDUCTION GEAR | **O** STACK | **U** FUEL TANKS |
| **C** TRACTION MOTOR BLOWERS | **J** MAIN TURBINE | **P** BRAKING RESISTORS | **V** CONDENSER FANS |
| **D** AIR CONDITIONING ALTERNATOR | **K** MAIN CONTROL CONTACTORS | **Q** BOILER DRAFT FAN | **W** AIR COOLED CONDENSERS |
| **E** TRAIN HEATING EVAPORATOR | **L** EXHAUST HEADER | **R** CONDENSER FAN TURBINE | |
| **F** MAIN GENERATORS | **M** BOILER | **S** FEED WATER PUMP | **Y** TRACTION MOTORS |



Top of boiler showing construction of steel casing assuring air tight casing

Drive end of Riley multiple retort clinker grinder underfeed stoker






**City of Detroit Lakes, Minn.**

50,000 lbs. per hour Riley Boiler Unit
Fired by Riley Underfeed Stoker
400 lbs. pressure—645°F. Steam Temperature
Charles Foster, Duluth, Minn., Consulting Engineer
Albert Frenzel, Chief Engineer

# DETROIT LAKES-

**TYPICAL PERFORMANCE**
**RILEY BOILER UNIT**
**CITY OF DETROIT LAKES, MINN.**

| | |
|---|---|
| Actual Steam Output | 304,000 |
| Total Coal Burned | 31,994 |
| Actual Evaporation per Pound of Coal | 9.53 |
| B. T. U. of Coal | 13,300 |
| Average Flue Gas Temp. | 460°F. |
| Average Operating Pressure | 350 lbs. |
| Average Steam Temperature | 600°F. |
| Overall Efficiency | 81.1% |

TRADE MARK Rx REGISTERED

# RILEY

**STOKER CORPORATION, WORCESTER, MASS.**

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore Milwaukee
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis

**It will pay you to visit modern Riley Installations**

View of furnace showing efficient shape of first tube bank eliminating stratification of gases

Clinker grinder pit showing cast Riley protecting blocks on water wall surfaces

# -excellent example low cost boiler unit

## RILEY STOKER FIRED BOILER UNIT OPERATES DAY IN AND OUT AT OVER 80% EFFICIENCY WITHOUT HEAT RECOVERY EQUIPMENT

The performance of the Riley Boiler unit at the City of Detroit Lak s, Minn., stamps this unit as an excellent example of a low cost, economically efficient boiler plant. Operating with monthly overall efficiency of over eighty per cent without heat recovery equipment, this Riley unit has proven to be the most economically efficient type of plant for the particular conditions existing.

A great deal of good old common horse sense is a good asset in designing any boiler plant. A plant designed to give the highest operating efficiencies will not of necessity give the highest economical efficiency. Load factor is a most important factor in determining the most economical type of plant to install.

At the Detroit Lakes Municipal Power Plant, a careful study indicated the necessity of an economical balance between relatively low load factor and permissible investment, a basic problem characteristic of many municipal plants.

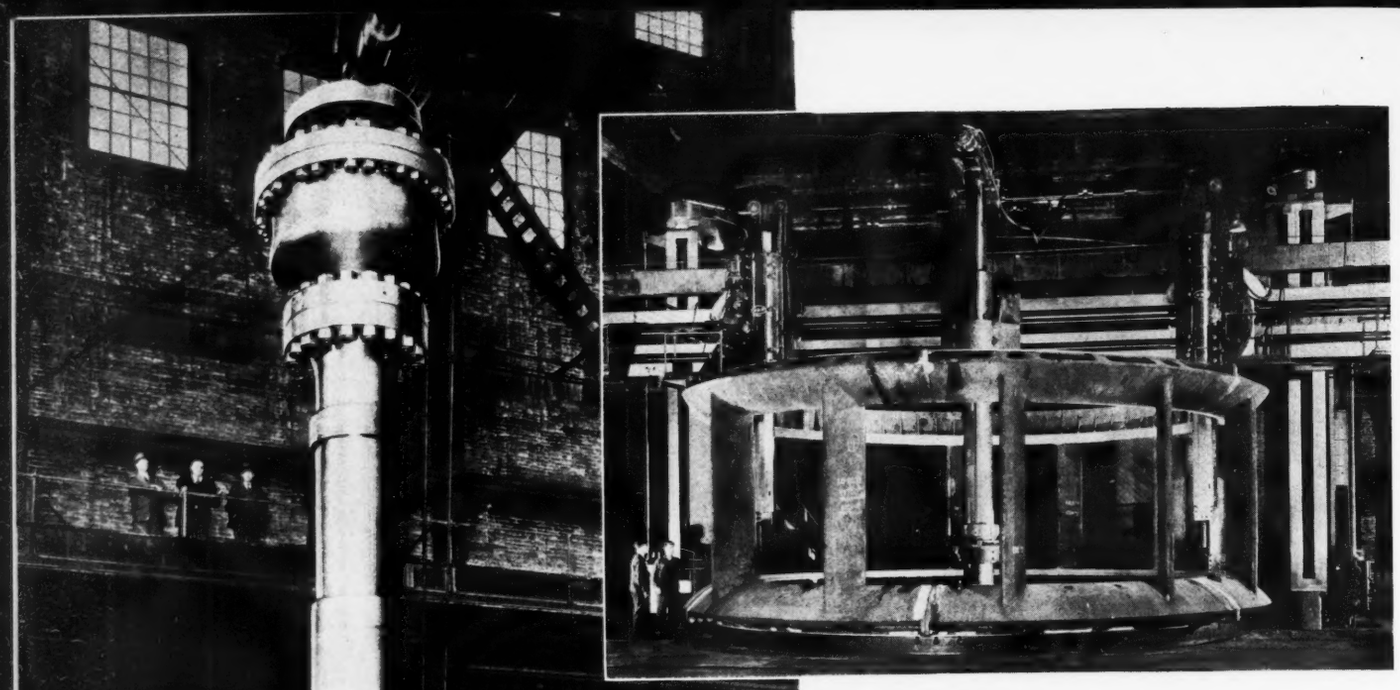
Proper consideration of these factors by the city's consulting engineer, Mr. Charles Foster, resulted in his decision in favor of a unit without heat recovery equipment. Results have proven this decision to be a wise one.

*A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs*

## COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

**before purchasing Boiler or Fuel Burning Equipment**

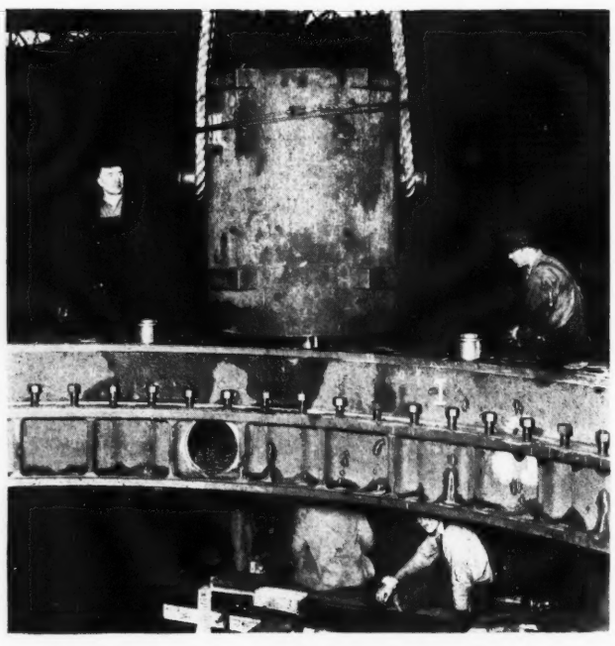


Above — Machining cast-steel speed ring for one of the 55,000-hp turbines. Through the openings between the guide vanes, 12,000 cu ft of water per second will flow to the runner at full turbine load

Center — Complete rotating hydraulic part consists of a runner with six adjustable blades, a 36-in. hollow forged-steel shaft with a servo-motor on top for adjusting blade position. The runner is over 24 ft in diameter and the assembly shown weighs 400,000 lb

Below—Pressing bronze bushings into guide-vane ring. These bushings form bearings for the bottom guide-vane stems. Guide vanes are operated by two servo-motors capable of exerting 630,000 ft lb

# Propellers Power Pickwick

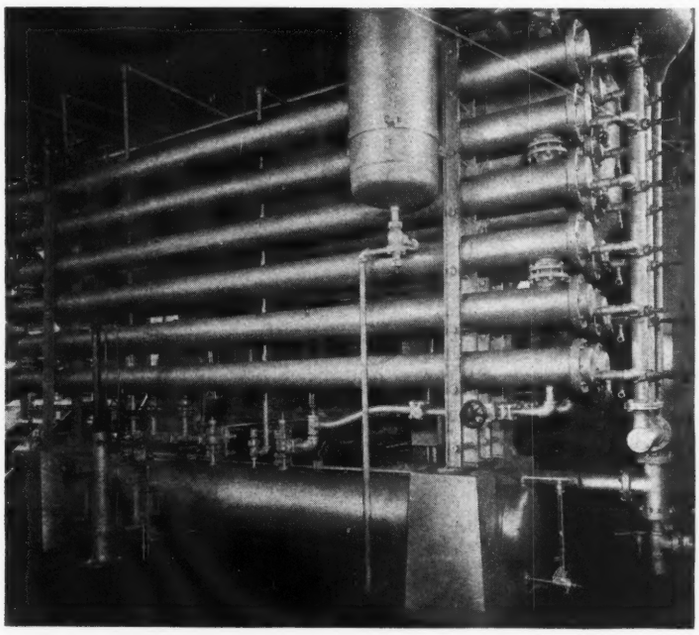


*TVA's Pickwick-Landing project, which went into operation last year, comprises a dam 7715 ft long, 113 ft high, and two 55,000-hp Allis-Chalmers Kaplan turbines at 47-ft head, with space for four more, or a total of 330,000 hp*

# —And Certain Death

*New chemical offers simple, low-cost treatment for recirculating cooling circuits in steam and diesel power plants, air-conditioning and refrigeration systems**

By H K NASON and J D FLEMING
*Monsanto Chemical Co*



INCREASED USE of heat-transfer apparatus, particularly with refrigeration and air conditioning, has created new problems in slime and algæ control for which chemicals formerly used are not entirely satisfactory. Reuse of cooling water in circulating systems must be accompanied by intelligent chemical treatment if heat-transfer efficiency is to be maintained, because such systems provide favorable growth conditions for algæ and slime-forming organisms.

The ideal chemical for slime control should possess the following properties: (1) High degree of toxicity to algæ, bacteria, protozoa. (2) Relatively low toxicity to man and higher animals. (3) Non-corrosiveness to metals used in engineering equipment. (4) Low volatility and high stability. (5) Ready solubility in water, and adaptability to feeding by simple equipment requiring a minimum of attention. (6) Ready availability in easy-to-handle form, at a reasonable price. Chemicals heretofore available did not meet all of these requirements. Consideration of known chemical and biological facts pointed to an organic chemical as the ideal, and using a special laboratory method, a large number of synthetic organic chemicals were tested.

Sodium pentachlorphenate was found to possess the properties wanted in an industrial algæcide. It is quite stable, the chlorine being firmly bonded to the phenol nucleus. In addition, it is relatively non-volatile, freely soluble in water, not corrosive to metals used in engineering construction, and available at a reasonable price.

Field tests under industrial conditions were made, in a number of localities and in a wide variety of installations. Two year's operating experience shows that in most cases 10 ppm of sodium pentachlorphenate will give good control of slime and algæ formations. Crenothrix and other so-called "iron bacteria" have also been controlled.

Application of sodium pentachlorphenate to cooling-water systems requires no complicated equipment, although standard types of wet- or dry-feed mechanisms may be used if desired. The chemical comes in 1-oz tablets or briquettes which may be allowed to dissolve slowly in a wire basket hung in a circulating-water passage.

The exact dosage of sodium pentachlorphenate required varies, depending on the organisms, extent of contamination, and environmental factors. Proper dosage can be found by experiment. The following procedure is recommended for systems already affected by slime and algæ deposits:

(1) Establish a concentration of about 30 ppm of chemical. (2) Maintain this for about 10-15 days, usually long enough to kill and remove existing deposits. (3) Gradually reduce chemical concentration over a period of 15-20 days until algæ growth just reappears. Then increase concentration by about 5 ppm and maintain by regular addition of toxic chemical.

Analytical methods for determination of sodium pentachlorphenate are available to aid in maintenance of any desired concentration.

## Losses Are Small

Since sodium pentachlorphenate is not volatile nor highly reactive chemically, it is not lost by evaporation or precipitation. Practically the only loss which must be replaced is that resulting from blowover (windage loss) and leakage. The daily makeup dosage is computed for these losses only, and not on total amount of water added to system; initial charge is computed from static capacity.

Principal cost of this treatment is cost of the chemical, which varies with the size of the system and the amount of water loss. For a typical cooling-tower system, serving a 55-ton Freon air-conditioning installation, the total cost for the 1937 season (April to November) was less than $5. On several large industrial systems, the cost has averaged about $0.75 per million gal.

The method of slime and algæ control outlined here may be applied to all industrial cooling-water systems where the bulk of the water is recirculated. It is not economically practical for systems where only a small part of the cooling water, or none at all, is recovered.

* Abstract of a paper presented at Fall Meeting of ASME, at Providence, R. I.

# Operating Experience at Essex

*In less than six months from initial operation, this 50,000-kw superposed unit, operating at 1250 lb and 950 F, has reduced station heat rate by one-third, and has been available 79% of the time up to Nov 1, 1938. Early troubles, while numerous, have not caused extended outage**

ADVANCES IN ENGINEERING of high-pressure plants have demanded complex supervisory equipment and new operating ideas, methods, and technique. Compare, for instance, the simple control panel for old boilers at Essex Generating Station of the Public Service Electric and Gas Company, New Jersey, shown at the left in Fig. 1, with the multiplicity of gages and controls on the panel at the right for the new boilers.

Long before the unit was placed in service, information was being supplied the men in a number of ways to prepare them for new duties. Supervisors were assigned to follow the progress of the work as representatives of the operating department. Manufacturers' representatives and heads of departments gave lectures. Key operators watched the progress of construction and aided the other men to become familiar with piping layout and with special features of the equipment.

Initial operating dates and gradual steps toward normal operation are recorded in Fig. 2 for each boiler and the turbine. The turbine had three short periods of operation with 225-lb pressure steam, during the second of which it was tripped off the line by improper motorizing-relay action. After this the spindle was returned to the factory for replacement of first-stage buckets as a result of experience had elsewhere with failure of bucket covers. In the final construction, the cover is integral with the bucket. A separate shroud, riveted to the cover provides additional stiffness by tying the buckets together in groups of four. New twin-oil-pump shafts were installed at the same time to overcome excessive vibration and reduce noise.

While the spindle was at the factory, the generator was operated as a synchronous condenser to study vibration and noise. The first run on June 2 was made in air, the second on June 3 in hydrogen. The third run on June 18, in air, was made to determine the effectiveness of hair-felt covering and temporary foundation reinforcing. This run was repeated on June 23 with a change in reinforcing arrangement.

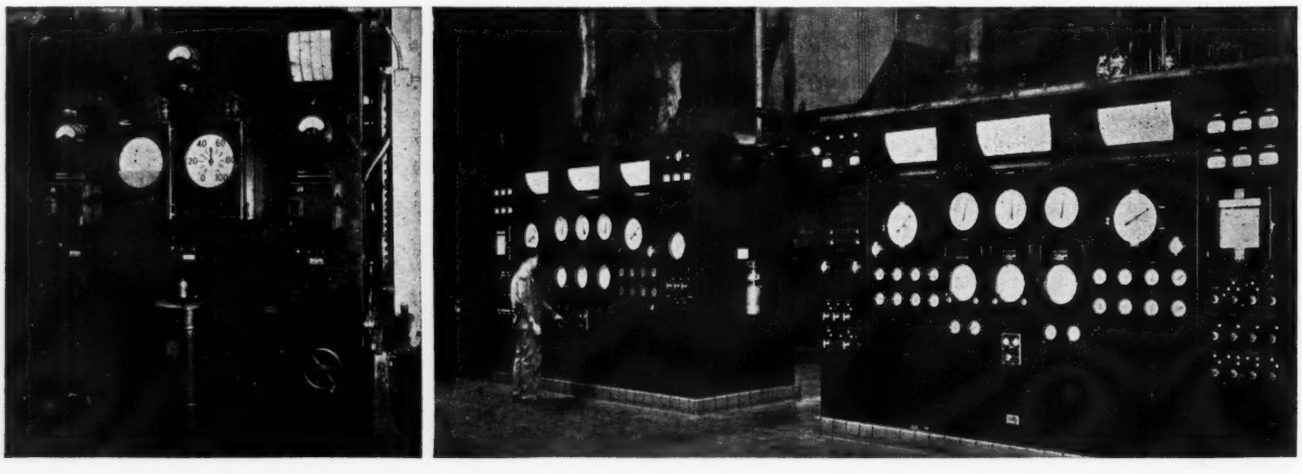
Because of the 2-pole generator construction which goes with 3600-rpm, 60-cycle generators, a double frequency vibration is set up by the deflection of the stator due to magnetic forces exerted by the poles. Since the stator laminations form a cylinder more than a foot thick to take these reactions, the amplitude is not great and no difficulty is expected to develop. Vibration of the relatively light generator shell results, however, in an objectionable noise, the solution for which has not yet been found.

The first high-pressure operation on July 2 was terminated before the unit was put on the line. Inspection revealed that a blank, previously installed in the oil line to the inboard turbine bearing for operation as a synchronous condenser, had not been removed. The fitting in which the blank was inserted had been loosened, and leakage passing below the inspection port gave a false indication of adequate return flow from the bearing. Before returning the unit to service the inboard bearing was replaced, low-pressure packing renewed, and the oil system cleaned.

The first run of any duration extended from July 22 to Sept 5. On July 23, the operator tripped the unit off the line on motorizing indication caused by a system surge. The ma-

* Based on a paper by W R LaMotte, Superintendent, Essex Generating Station, Public Service Electric and Gas Company, presented before the Metropolitan Section of ASME, Nov. 17, 1938.

Fig. 1—Compare the simple operating panel of the old boilers at the left with the multiplicity of meters and controls for the high-pressure units at the right



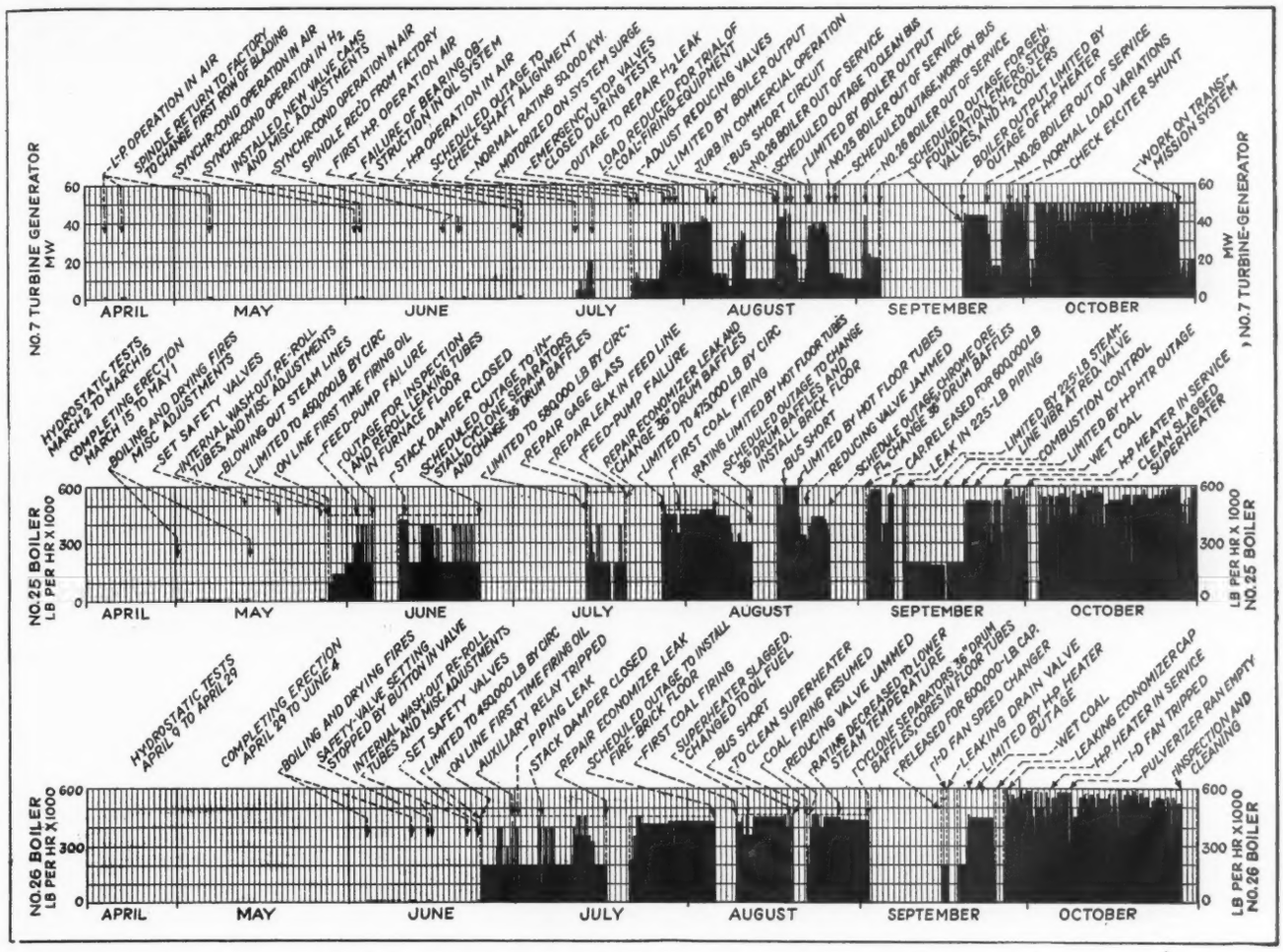



Fig. 2—A detailed log of early outages briefs the operating record of turbine and boilers

chine was immediately returned to service. On July 28, load had to be taken off the unit to free one of the emergency stop valves that had gone full closed during test for freedom of movement.

## Hydrogen System

At the outset, hydrogen consumption was 600 cu ft per day. Most of the leakage was found to be at the plate supporting the generator-lead bushings. On July 29, at full speed and with the field off the generator, the armature leads were short-circuited and grounded while the joint was tightened. Hydrogen loss fell to 40 cu ft per day while maintaining a purity of 96 97%.

Commercial operation dates from Aug 17 when the unit was loaded to 50,000 kw for the first time. Two days later, a bus short-circuit caused momentary shutdown. The run to a scheduled outage on Sept 5 was then completed without further difficulty.

At this time (1) the emergency stop-valve test-lever arrangement was redesigned (2) a permanent lateral beam was installed on the generator foundation (3) hydrogen-cooler fin tubes were reinforced and (4) generator sole-plates were grouted to give support over the full length of the casing rather than only at the four corners.

The effect of double-frequency vibration was noted on the hydrogen tubing under the generator where, in a number of supporting brackets, it was found worn almost through. This condition has been corrected by mounting the tubing in rubber.

The turbine was returned to service on Sept 20 and, with the exception of a scheduled shut-down on Oct 2 to remove the exciter shunt, was in service through the month of October.

The first boiler was equipped with an extensive set-up of temporary pressure connections, pitot tubes, level detectors and thermocouples. This precaution proved well worth while in checking circulation troubles, carry over, and gas-flow distribution as described later.

## First Boiler Run

The first operation of No. 25 Boiler, excluding drying and boiling-out fires and setting safety valves, took place on May 28 with oil firing. On this run a shut-down occurred on June 2 because of improper governor action of the secondary feed pumps. The run was concluded on June 5. Rating was found to be limited to 450,000 lb per hour because of improper circulation. A number of leaking joints at floor-tube headers were rerolled.

The boiler returned to service June 10. On the following day, at 400,000-lb-per-hour load, the pin holding the stack shut-off damper was dislodged by vibration and the damper closed. The boiler was shut-down and all such pins were replaced by bolts before resuming operation. The run continued until June 25 with output limited to 450,000 lb per hour by circulation.

During the 19-day outage that followed, changes were made in the 36-in. drum baffles and cyclone separators were installed in the 60-in. drum. As a result of these changes, allowable rating increased to 580,000 lb per hour. The bicolor gage glass was repaired on June 14. On July 18, the boiler was shut down to repair a leak in the feedwater line and returned to service on the following day. On July 20, trouble with the secondary-feed-pump governors again caused an outage. A leak developed in a shop weld in an economizer tube on July 21 and the jet action cut two adjacent tubes.

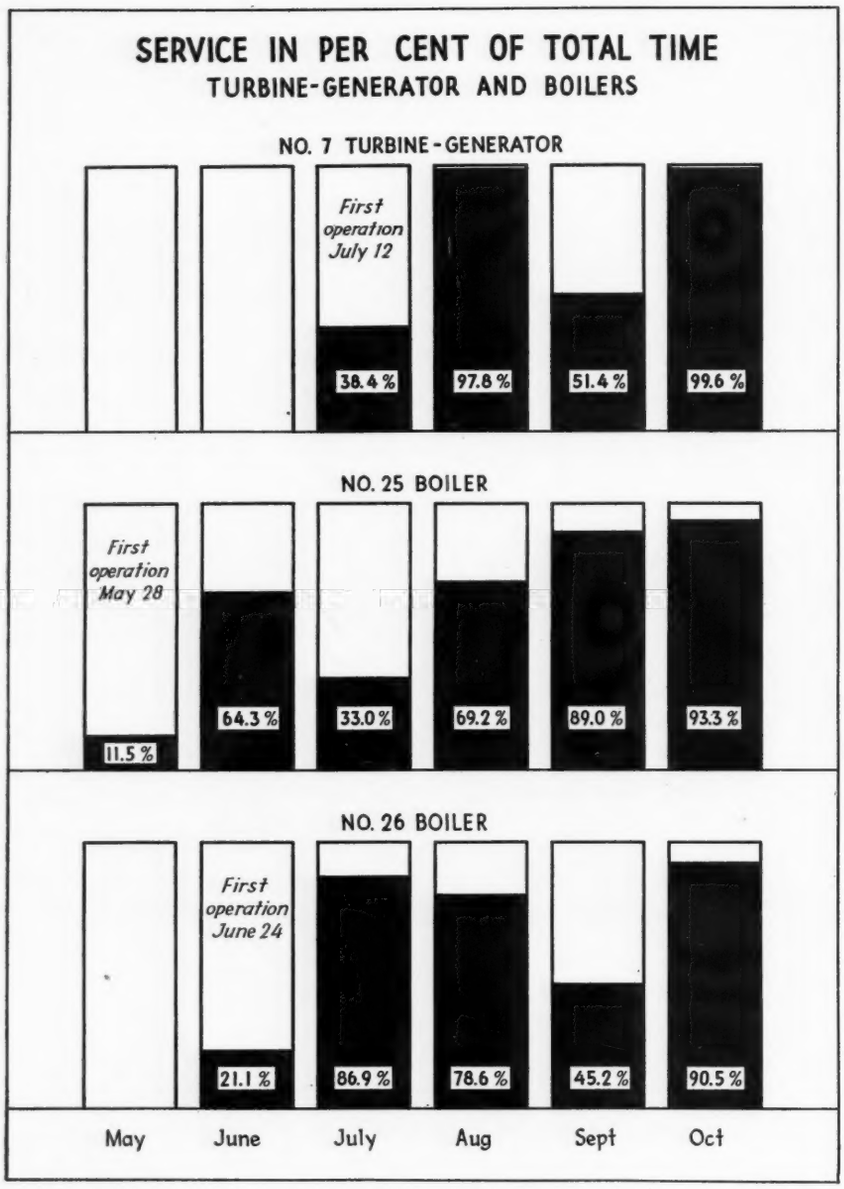



**Fig. 3—The service record does not measure the tension on an operator's nerves, but does indicate a steady rise in service-availability factor in only a few months**

While economizer repairs were being made, the baffles in the 36-in. drum were changed for the second time. These changes lowered allowable rating from 580,000 to 475,000 lb per hour.

Pulverized coal was fired for the first time on July 30. On Aug. 6, floor-tube metal temperature rose to 715 F, limiting output to 300,000 lb per hour. Efforts to cover the floor with crushed firebrick during operation were without results.

On Aug 13, a 4½-in. course of firebrick was laid on the primary furnace floor. During this outage, the 36-in. drum baffling was revised for the third time, this time removing any limitation of boiler output due to circulation up to full load of 605,000 lb per hour. Boiler-water solids concentration limit, however, was reduced from 350 to 300 ppm at full load.

On Aug 19 the bus short previously mentioned took out all boiler auxiliaries due to operation of the low-voltage relay. On Aug 21, further difficulty was experienced with overheated floor tubes, the brick floor having completely disappeared in some sections. Output was again limited to 330,000 lb per hour.

During the outage commencing Aug 27, the 36-in. drum baffles were changed for the fourth time. Also a chrome-ore floor was installed in the primary furnace varying in thickness from ½ in. at the front of the furnace to 7 in. at the slag screen. The chrome ore is held in place by a water-cooled dam consisting of three rows of fins welded to floor tubes and carrying two 1-in. water lines. The fins were packed with chrome ore level with the main floor. Since making these changes to drum baffles and primary-furnace floor, no troubles have been experienced with either circulation or overheated floor tubes.

The boiler was returned to service on Sept 2 but had to be taken off the line to repair piping on the low-pressure side of the reducing valve when a crack developed in the drain piping of the separator. Boiler rating then had to be reduced to 200,000 lb per hour until additional supports were installed to reduce the excessive vibration of the pipe.

On Sept 16, while transferring from automatic to manual combustion control, the air-fuel ratio functioned improperly, boiler pressure rose to 1320 lb and a positive pressure was placed on the pulverizers. To correct conditions, the operator had to trip out the fuel supply.

No slagging difficulties were experienced on No. 25 Boiler until Oct 1 when the first row of tubes behind the superheater screen tubes was found solidly slagged one-half the way from bottom to top. The economizer bypass section was found dirty but not plugged. Air lancing during operation was ineffective because of inaccessibility, but during the shut-down the slag was easily removed by rodding and blowing.

Except for this outage from Oct 1 to 3, the remainder of the month was without any event of note for No. 25 Boiler.

### Boiler No. 26

No. 26 Boiler differs from No. 25 only in that the furnace slag screen separating primary and secondary furnaces was omitted. There has been insufficient operation to date to determine definitely the value of the furnace slag screen. The temperature of gas entering the superheater is about 100 F higher in the furnace without the screen, making it necessary to bypass more gas through the economizer. No troubles have been experienced with the screen.

This boiler was first fired with oil on June 24. On June 30, an electrician working on the relays tripped the auxiliary-power relay and the boiler shut down. On July 1, a leaking desuperheater-water line at the reducing valve was rewelded.

On July 5, an iron worker, working on the flues to the stack, decided that the stack-damper arm was in his way. Even though, as a result of the stack-damper episode on No. 25 Boiler, the arm was securely bolted, he removed the bolt and the stack damper closed.

On July 17, a leak developed in the economizer section. Later a brick floor was laid similar to that in No. 25.

First coal firing occurred on Aug 10 and the boiler carried 440,000 lb per hour until Aug 12 when it was

necessary to return to oil firing and limit rating to 350,000 lb per hour because of slagging the superheater. Soot blowing, air lancing, and steam lancing were without result so the unit was taken off the line for cleaning.

On Sept 2, cyclone separators were installed in the 60-in. drum, baffles were changed in the 36-in. drum, cores were installed in the floor tubes, and an additional soot blower was located in the superheater section.

On Sept 16, the speed changer of the induced-draft fan tripped out the fan and, in turn, the boiler. At this time a leaking economizer-header drain valve also was repaired.

For twenty days following, only a leaking economizer-header cap gasket and a momentary shut-down due to tripping out a fan while transferring from low to high speed were noted.

Because of improper action of a pulverizer suction damper on Oct 8, a false coal-level indication resulted in running empty the one pulverizer in service. A change was made to oil fuel before steam pressure fell off. On Oct 29, work on the transmission system permitted inspection and cleaning.

As of Nov 1, the turbine had 2124 hours of service, 79% of the period from July 12 to Nov 1. No. 25 Boiler operated 70% and No. 26, 76% of elapsed time from initial operation.

Effect of the new unit on station heat rate is indicated by the monthly figures for March, 20,836 Btu per kwhr, and October 13,983. Several daily operation figures under favorable-load conditions have been below 13,000 Btu.

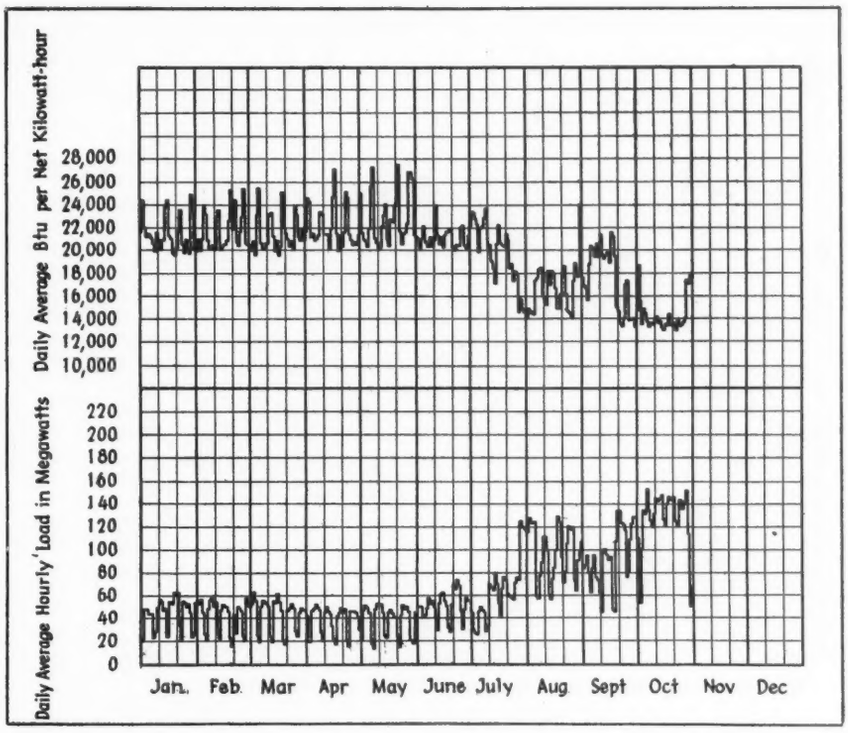


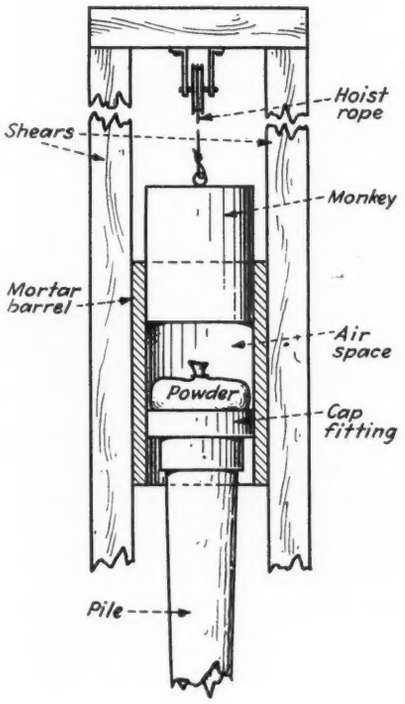

**Fig. 4—Does an efficient and well designed superposed unit do things to the record? The change in heat rate is definite. Increased load shown in the lower graph is earned by better heat-rate performance**

In retrospect, the short period of operation to date has included no serious difficulties. Shut downs have occurred, but no prolonged outages of equipment have been necessary.

✦ ✦ ✦

# Gunpowder Piledriver

By ROBERT GRIMSHAW




SOME YEARS AGO I had to take a civil service examination in engineering at the Department of Commerce in Washington. As I had already passed such a test in New York and just naturally thought I knew what it was all about, it struck me that I might have some fun with my examiners. So, when asked to explain the how and wherefore of the diesel engine, my answer, as was intended, told the Board something it had not known. I told them the diesel engine was a development of the principle demonstrated by Thomas Shaw of Philadelphia in an invention presented before the Franklin Institute in the Seventies, an invention known as the "gunpowder piledriver".

As shown to members of the Franklin Institute's Committee on Sciences and the Arts, the essential feature of the invention was a mortar or howitzer, enveloping the top of the pile which carried a cap fitting. The long cylindrical "monkey" normally used for pile driving fitted the barrel of the mortar snugly, and was used to drive the pile part way. Then, with the monkey at the top of the "shears" as the guide timbers are usually called, the operator placed a package of old-fashioned black blasting powder (sulphur, niter, and charcoal) in the barrel of the mortar (see sketch).

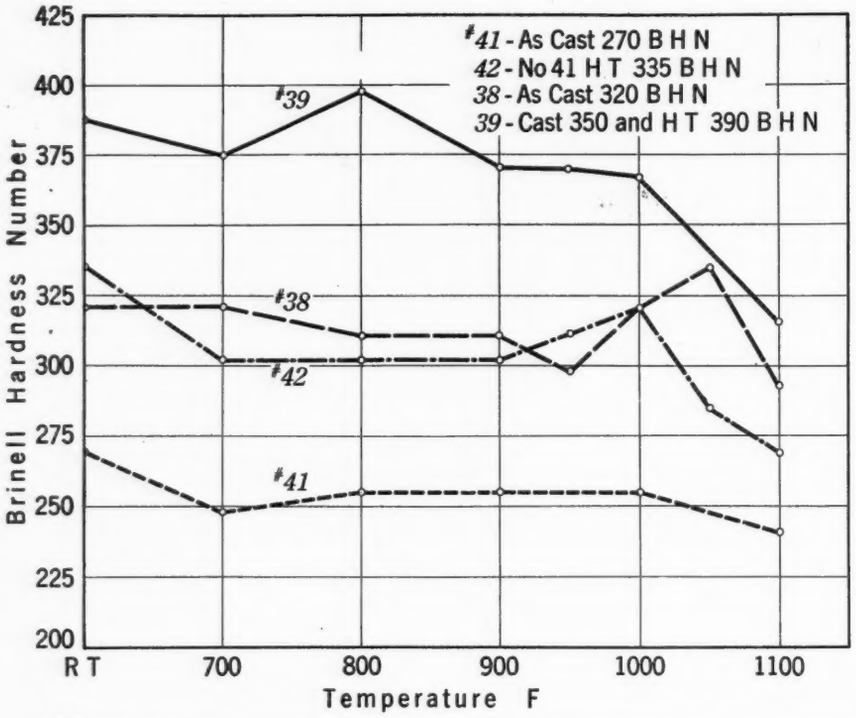
At the right instant, the monkey descended at the usual rate determined by the laws of gravity (less slight loss by friction), entered the snugly fitting mortar barrel and compressed air therein, causing sufficient heat to explode the powder charge.

The explosion drove the monkey to the top of the shears and drove the pile to a depth determined by the consistency of the mud.

What Shaw did not realize but what Diesel would have known had he hit on the idea of a compression pile-driver was, that if the shears were long enough, and the monkey heavy enough, almost any explosive charge could be used that would not burst the barrel, such as petroleum.

# Putting the Heat on Valve Materials—II

***Continuation of hardness study reveals how valve-trim materials will stand up under temperatures up to 1100 F***



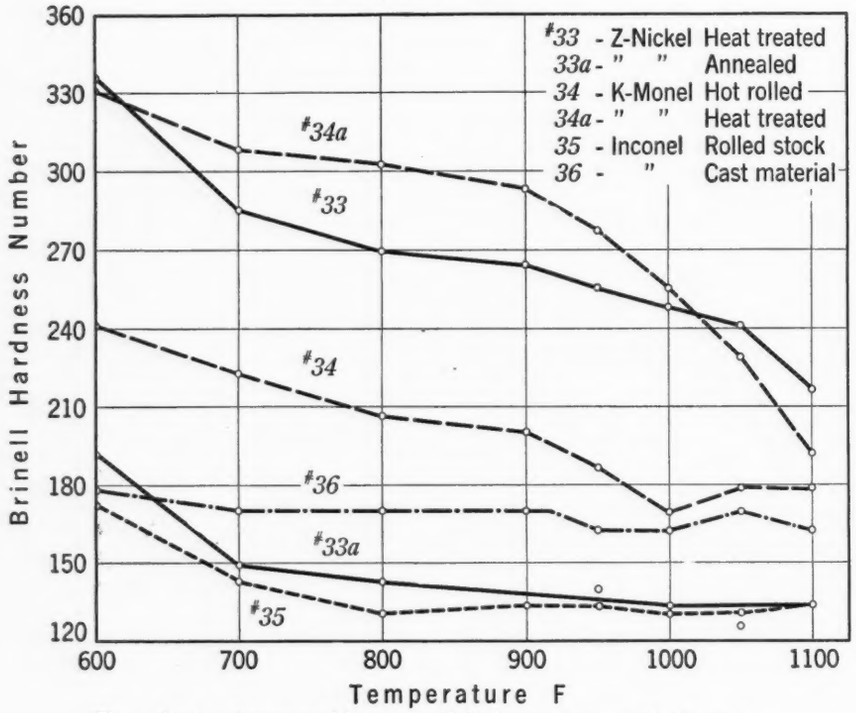




Fig. 1 (top)—As-cast and heat-treated S-Monel. Fig. 2—Nickel alloys

Fig. 3—S-Monel cylinder liner for 12-in. non-return valve at 1500 lb, 900 F

By M G BOLINGER and Wm HEILIG

*The Wm Powell Co, Cincinnati, Ohio*

THIS STUDY is a continuation of one previously made on high-temperature hardness properties of various alloys. (See POWER, April, 1938, pages 89-91). Of the alloys previously studied, several gave real promise as material suitable for high-temperature operation. A further study was undertaken of these to give additional data on their performance. The results of this study, with certain new alloys and a general relisting of some of the more outstanding classes of alloys previously reported, are given in Table I.

When the power-plant engineer and designer set up specifications for materials that enter into fabrication of a complete power-house assembly, they are vitally concerned with the effect high temperatures will have on physical properties, such as ultimate tensile strength and creep limits, of the materials used. However, since it is usually not stressed, they perhaps overlook another important factor, the effect of temperature on hardness. This becomes a rather serious item when operating conditions depend upon a high degree of hardness.

The non-ferrous alloy commonly known as "S" Monel exhibited such excellent high-temperature properties that a series of tests were made for further study of the alloy. Specimens were prepared over a rather wide range of hardness. Tests were made both in the "as cast" and "heat treated" conditions. The graphs, Fig. 1, give results of four different series of tests representing varying degrees

of hardness. Tests No. 41 and 42 were made with specimens from the same heat, the former in the "as-cast", the latter in the "heat-treated" condition. It is to be noted that the hardness of the "as cast" material usually does not drop to any great extent at the more elevated temperatures. In some cases, see Fig. 1, No. 38, there is an actual increase due to age hardening. This is not noted in initially heat-treated specimens.

Several other non-ferrous alloys, notably "K" Monel, Inconel, and "Z" Nickel exhibited unusually good high-temperature hardness properties. The graphic results of tests on these alloys are shown in Fig. 2. "Z" Nickel gives every evidence of being another good alloy for high-temp service.

One of the most important features of the temperature effect is noted after the test specimens have cooled to room temperature. On all the chromium irons, the initial room-temperature hardness of the specimens usually dropped after being subjected to the high test temperatures. See Table I. This was not true of the "S" Monels, the cast Inconel and the annealed "Z" Nickel specimens. In the case of heat-treated "Z" Nickel there was only a very slight drop. This is a significant factor in the operating cycle of valve parts when it is considered that some steels subjected to a temperature of 900 F lose 0-9% of their initial hardness, and at 1100 F lose 0-35% of their initial hardness.

In this study we have endeavored to secure a better appreciation of the role of hardness in relation to temperature and a guide to a selection of materials for use at elevated temperatures.

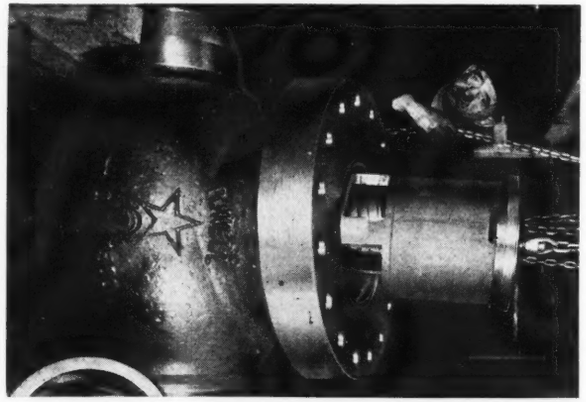


Fig. 4—Cast-steel toggle-operated non-return valve. Cylindrical guide for disk and disk itself are made of cast S-Monel heat treated to 320-350 Brinnell Hardness

TABLE I — HARDNESS AT ELEVATED TEMPERATURES

| *Material* | *Remarks* | *Spec No.* | *Room Temp* | *Temperature — F* 700 | 800 | 900 | 950 | 1000 | 1050 | 1100 | *Drop from room — temperature hardness after testing* at 900 F | at 1100 F | *Alloy Composition* Ni | Cu | Si | Fe | C | Mn | Cr | Co | W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stellite No. 6 | Surface applied | 9-b | 404 | 290 | 277 | 269 | .... | 240 | 234 | 285 | −0.0% | −0.0% | ..... | ..... | .... | .... | .... | .... | 29. | 65. | 6. |
| Stellite No. 12 | Surface applied | 8-b | 472 | 363 | 370 | 352 | .... | 341 | 321 | 269 | −0.0 | −0.0 | ..... | ..... | .... | .... | .... | .... | 33. | 57. | 10. |
| 13% Cr-Fe | HT — 300 BHN | 4-b | 302 | 260 | 255 | 229 | .... | 207 | 187 | 143 | −2.6 | −11.0 | ..... | ..... | .42 | Bal. | .13 | .50 | 12.70 | .... | .... |
| 13% Cr-Fe | HT — 375 BHN | 4-a | 379 | 341 | 341 | 300 | .... | 239 | 212 | 148 | +1.9 | −19.3 | ..... | ..... | .42 | Bal. | .13 | .50 | 12.70 | .... | .... |
| 13% Cr-Fe | HT — 400 BHN | 4-y | 408 | 363 | 363 | 360 | 341 | 331 | 302 | 170 | −0.0 | −33.4 | ..... | ..... | .42 | Bal. | .13 | .50 | 12.70 | .... | .... |
| 13% Cr-Fe | HT — 450 BHN | 4-x | 444 | 415 | 415 | 415 | 415 | 363 | 269 | 163 | −0.0 | −33.3 | ..... | ..... | .42 | Bal. | .13 | .50 | 12.70 | .... | .... |
| 15% Cr-Fe | HT — 500 BHN | 6 | 514 | 506 | 470 | 450 | .... | 415 | ..... | 170 | +1.6 | −31.4 | ..... | ..... | .28 | Bal. | .38 | .44 | 14.90 | .... | .... |
| 17% Cr-Fe | HT — 550 BHN | 23 | 550 | 514 | 543 | 469 | .... | 285 | 170 | 126 | +0.7 | −34.5 | .20 | ..... | .23 | Bal. | 1.04 | .46 | 16.76 | .... | .... |
| S Monel (3.5 Fe) | AC — 250 BHN | 13-a | 255 | 229 | 255 | 229 | 255 | 262 | *293 | 255 | +10.0 | +20.0 | 62.55 | 29.92 | 3.13 | 3.43 | .16 | .75 | ..... | .... | .... |
| S Monel (3.5 Fe) | HT — 300 BHN | 13-b | 296 | 269 | 262 | 273 | .... | 255 | 266 | 229 | +1.7 | +11.1 | 62.55 | 29.92 | 3.13 | 3.43 | .16 | .75 | ..... | .... | .... |
| S Monel (Standard) | AC — 270 BHN | 41 | 270 | 248 | 255 | 255 | .... | 255 | ..... | 241 | −9.4 | −10.9 | 62.92 | 30.23 | 3.30 | 2.59 | .48 | .35 | ..... | .... | .... |
| S Monel (Standard) | HT — 335 BHN | 42 | 336 | 302 | 302 | 302 | .... | 321 | 285 | 269 | −0.0 | −0.0 | 62.92 | 30.23 | 3.30 | 2.59 | .48 | .35 | ..... | .... | .... |
| S Monel (Standard) | AC — 320 BHN | 38 | 321 | 321 | 311 | 311 | 298 | 321 | 335 | 293 | +2.8 | +5.7 | 62.79 | 28.42 | 3.91 | 3.98 | .08 | .80 | ..... | .... | .... |
| S Monel (Standard) | HT — 390 BHN | 39 | 388 | 375 | 398 | 371 | 370 | 367 | ..... | 316 | +1.2 | +2.5 | 62.97 | 28.56 | 4.60 | 3.18 | .04 | .64 | ..... | .... | .... |
| Inconel | As hot rolled | 35 | 172 | 143 | 131 | 134 | 134 | 131 | 131 | 134 | −0.0 | −0.0 | 78.84 | .28 | .23 | 7.30 | .06 | .19 | 13.07 | .... | .... |
| Inconel | As cast | 36 | 178 | 170 | 170 | 170 | 163 | 163 | 170 | 163 | −0.0 | −0.0 | 81.82 | ..... | 1.91 | 7.41 | .... | .... | 8.86 | .... | *Al* |
| K Monel | As hot rolled | 34 | 241 | 223 | 207 | 201 | 187 | 170 | 179 | 179 | +5.0 | +40.0 | 63.66 | 30.15 | .32 | 1.47 | .20 | .97 | ..... | .... | 2.61 |
| K Monel | Hot rolled, HT | 34-a | 331 | 311 | 302 | 293 | 277 | 255 | 229 | 192 | −4.0 | −17.5 | 63.66 | 30.15 | .32 | 1.47 | .20 | .97 | ..... | .... | 2.61 |
| Z Nickel | As hot rolled | 33-a | 192 | 149 | 143 | 134 | 140 | 134 | 126 | 134 | +2.7 | +8.4 | 98.24 | .10 | .11 | .31 | .27 | .16 | ..... | .... | .... |
| Z Nickel | Hot rolled, HT | 33 | 336 | 285 | 269 | 262 | 255 | 248 | 241 | 217 | −0.0 | −1.6 | 98.24 | .10 | .11 | .31 | .27 | .16 | ..... | .... | .... |

* Held 12 hr at 1050 F
HT — Heat treated
AC — As cast
BHN — Brinnell hardness number
C Carbon
Co — Cobalt
Cr — Chromium
Cu — Copper
Fe — Iron
Mn — Manganese
Ni — Nickel
Si — Silicon
W — Tungsten
Al — Aluminum

# Exhaust Pipe Follows Turbine

*Steam-heated anchor keeps exhaust pipe in step with turbine-casing expansion*

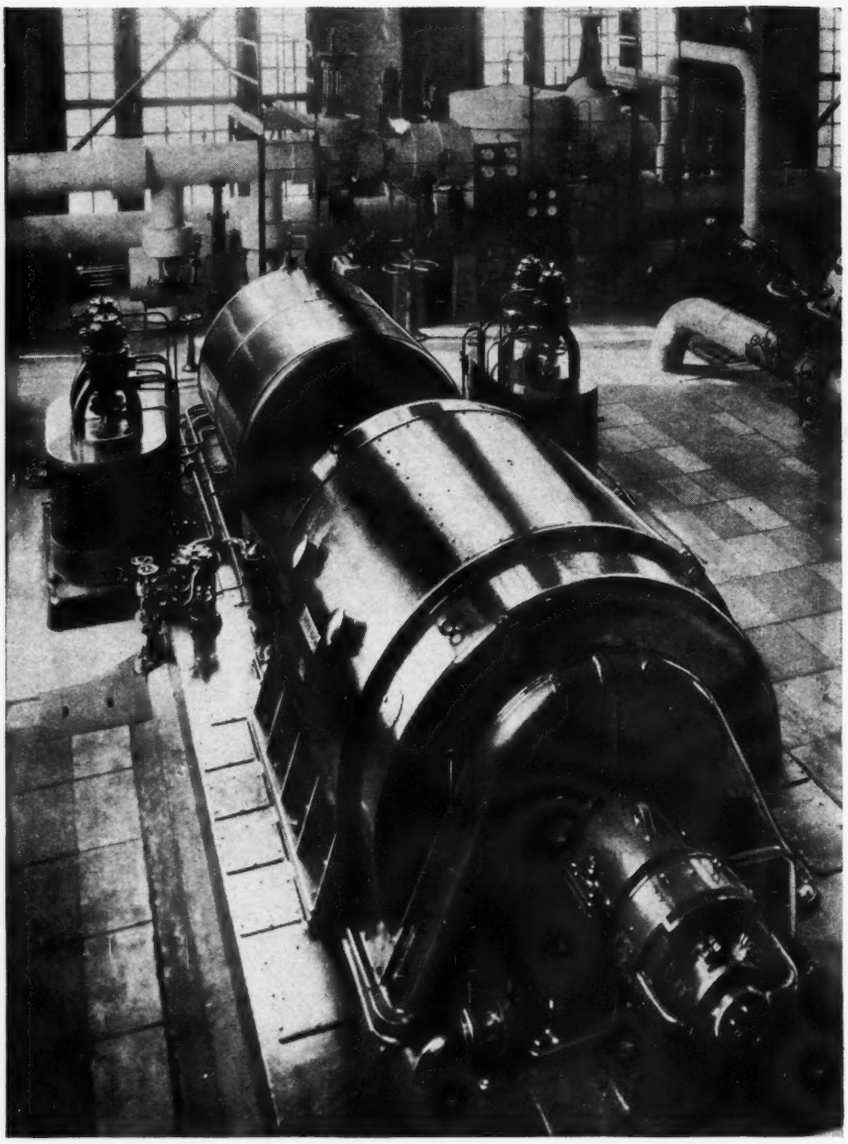


Fig. 1—This 7,500-kw, 27-stage turbine has 4 steam-control valves, two on each side

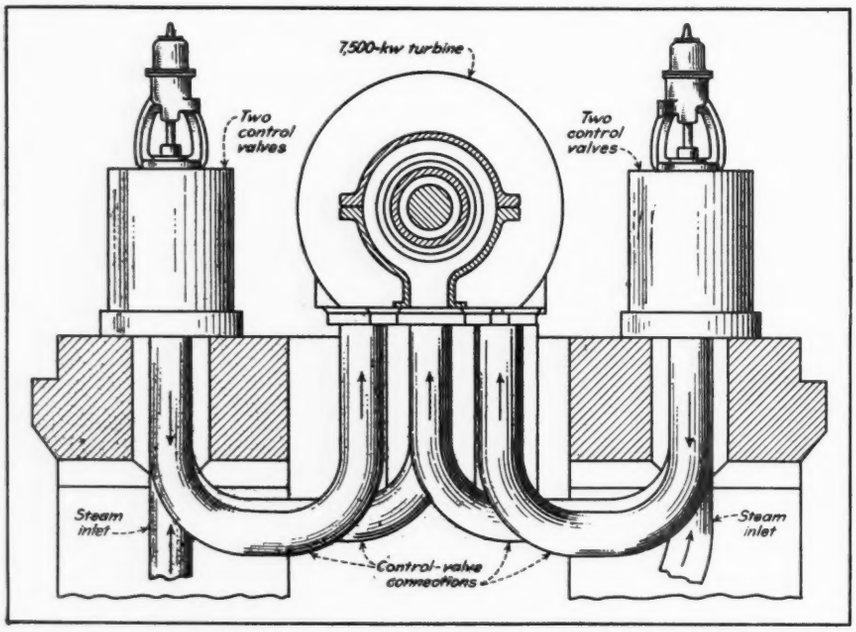



Fig. 2—Control-valve connections loop down under the turbine

A UNIQUE METHOD is being used to prevent the exhaust pipe from causing expansion and contraction stresses in the high-pressure turbine casing at the Dominion Steel & Coal Corp's plant, described on pages 50-54, November POWER. This 3600-rpm, 7500-kw, Brown-Boveri turbine, Fig. 3, has 27 stages and four control or steam-inlet valves, two on each side of the machine (see Fig. 1), and all four are governor controlled.

No. 1 valve opens and admits steam to the high-pressure end. Above 25% load, No. 2 valve opens and takes in steam between the 10th and 11th stages for operation up to 50% load. At this point, valves 3 and 4 open and admit steam between the 16th and 17th stages. Connections from the valves loop down under the turbine, as shown in Figs. 2 and 3.

The high-pressure end of the turbine is next to the generator; consequently, the governor is driven from the low-

pressure end of the rotor shaft. The high-pressure end of the turbine is fixed, the casing being free to expand toward the low-pressure end. Under conditions of greatest casing expansion, the lower-pressure end will move about 0.5 in.

The low-pressure end connects to the 150-lb steam main by a 20-in line with a Foster-Wheeler expansion joint in it, Fig. 3. The exhaust line is anchored at the end away from the turbine. Therefore, expansion of the 150-lb connection and that of the turbine oppose. This led the designing engineers to believe that the exhaust connection might cause serious stresses in the turbine casing.

### Exhaust-Pipe Anchor

To insure against this, a piece of heavy 6-in. steel pipe, closed at each end, is anchored at one end to a hinged steel-rail foot set in concrete foundation under the high-pressure end of the turbine, and at the other end rests and is hinged against the exhaust-pipe elbow, Fig. 3. Connections are made from the control-valve loops into the closed pipe as shown, so that it is heated to approximately the same temperature as the turbine section. The pipe expands approximately at the same rate as does the turbine and pushes the exhaust-pipe connection with it, the expansion joint taking all movement of the anchor.

Condensate in the loops between control valves and turbine drains into the 6-in. pipe section and is trapped out into the condensate return. The pipe section, therefore, serves the double purpose of making the exhaust-pipe follow the turbine and acting as a hotwell into which the control-valve loops drain.

Expansion in the horizontal section of the 20-in. exhaust connection is also taken care of by the expansion joint. This joint is of a special packless bellows type known as the 18—8, stainless-steel design. The whole arrangement of pipe strut and special expansion joint has worked out very satisfactorily in service.

Information for this article was supplied by W S Wilson, chief engineer, and A H Cuzner, superintendent of power plants, Dominion Steel & Coal Corp, Sydney, N. S.

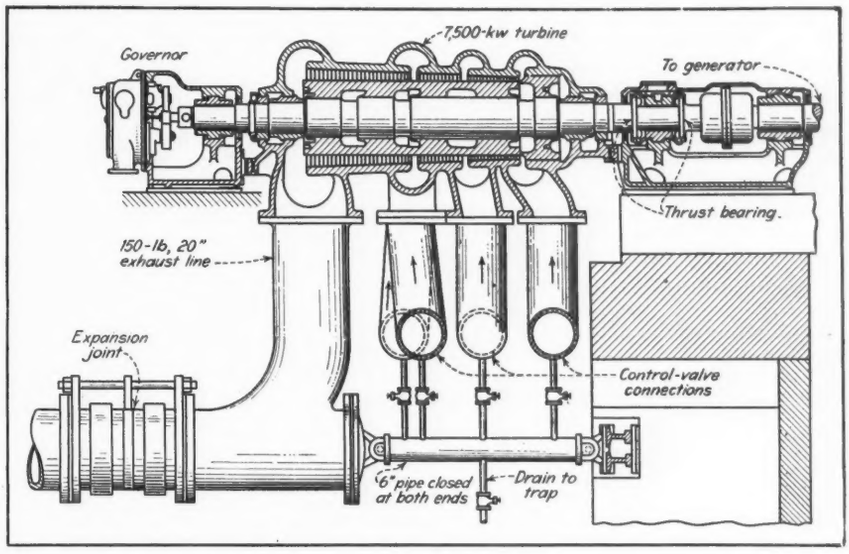
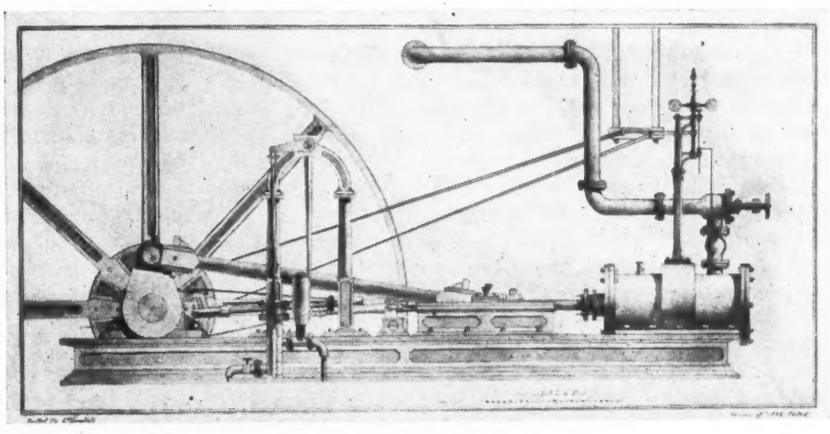



**Fig. 3—Six-inch pipe strut also drains control-valve connections**

✦ ✦ ✦

# Grandad of the Corliss



NINETY-SEVEN YEARS OLD, this primeval prime mover is still going strong. Built in 1841 by James Brooks Co for French Richards Co (now Samuel T French Co, Philadelphia), the engine was disassembled in 1856 and moved to its present location. The drawing was made at that time by Samuel T Longstreth, whose nephew, Edward T Longstreth, is now vice-president of this paint-manufacturing company.

Two leather belts used for the main drive and the jackshaft to the line which drives the main plant, have served 92 years, which should be a record for leather or any other belting material. The main drive belt was a 3-ply oak, 36 in. wide, now worn down to 31 in. wide. Note the old-fashioned open grease cups on which animal fat was placed, so that as it melted from frictional heat it ran into the bearings.

The great care used in making this drawing is typical of the craftsmanship of the past century which enabled older, cruder machinery to serve well past its expected lifetime. The drawing is reproduced through the courtesy of E F Houghton & Co, who has supplied the belt dressing for many years.

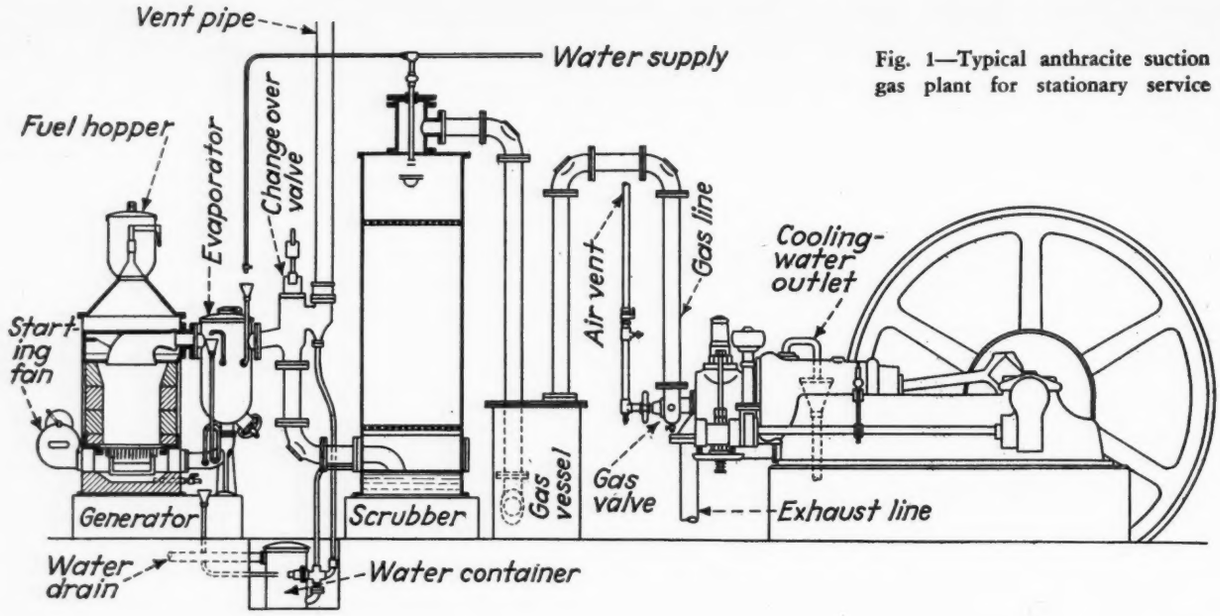



Fig. 1—Typical anthracite suction gas plant for stationary service

# Europe Turns to Gas Producers

*Reports of advances in application to transportation, marine, and stationary service have reawakened American interest in this forgotten field. This article highlights significant technical features of modern European gas-producer practice*

By F A M WULFINGHOFF

PRODUCER-GAS ENGINES have always been favored in many rural districts of Europe, especially where electricity is expensive or not available. In agricultural regions, sawmills and flour mills will often be found with a producer-gas installation as a power source combined with an additional electric generator and accumulator system to keep load on the prime mover nearly constant. Apart from the economy of this arrangement, its outstanding advantage is simplicity. Usually operated at moderate speeds and compression ranges, producer-gas engines are long lived, and most mill attendants know how to run them. Fig. 1 shows a typical stationary producer unit for burning anthracite.

However, it is the recent development of producer units for transportation service that has focussed attention on this equipment. An increasing number of countries with insufficient fuel reserves of their own offer tax reductions or even subsidies for the use of solid fuels in motive units, and so producer plants have been developed for automobiles, trucks, buses, railway cars, switching locomotives, and river craft. The smallest commercial producers today are rated for 16-18 hp, about 1300 cu ft of gas per hour.

Depending on local circumstances, such producers may run on natural, air-dried, or artificial fuels, or mixtures of these. Artificial fuels are usually obtained from natural products by coking, carbonization, or briquetting. Although fuels high in volatile matter give gas with good heating value, the tendency is to put to use low-grade materials, too low in volatile matter to be recuperated separately, such as anthracite, cokes, medium-rank bituminous, lignite, wood and peat. Table I gives data on such fuels, from the point of view of European practice.

Good producer fuel should have high reactivity, enough volatile matter, a satisfactory carbon-ash ratio (preferably greater than 3:1) suitable size, and low tar content. Fineness should be such that passage of air and gas remain unimpaired through its entire course. Fuel must not lose bulk in the fire; a collapsing fuel prevents continuous operation.

Wood charcoal and wood are paramount for automotive producers because low sulphur and ash content simplify design and operation and reduce cost. Charcoal gives perhaps more convenient operation than wood, but is not available everywhere. Average automotive plants have a capacity of 100 lb or more. Charcoal is generally sold in 90-lb paper bags which can be handled conveniently, avoiding dust and dirt.

Wood that has been exposed to the atmosphere for 6-12 months usually has the right moisture content and can be introduced into the fire zone without additional water vapor. Too high a moisture content means unnecessary heat dissipation, plugged gas filters, and difficult starting. When possible, beech, birch, or oak is used in prefer-

ence to soft wood which yields a soft charcoal tending to clog passages and cause more frequent cleaning.

Too coarse a fuel will not slide down evenly, but will form cavities which tend to lower gas quality. Bigger producer units permit larger fuel sizes to be used. Where sawdust must be disposed of, it is best shaped into briquettes, with pitch or tar as binder. For large units burning wood, up to 20% of fuel volume may be sawdust or chips.

Properties of peat coke are similar to those of charcoal, which permits designing producers on identical lines; however, a fineness of 1-1½ in. is recommended. Anthracite and bituminous carbonization coke require more spacious gas-cleaning apparatus because of higher ash content and higher percentage of undesirable components such as sulphur. With lignitic carbonization coke, which contains far more ash, brickwork is replaced with a heat-resisting cast-iron insert. Gas cleaners for the latter fuel, however, remain the same as for anthracite.

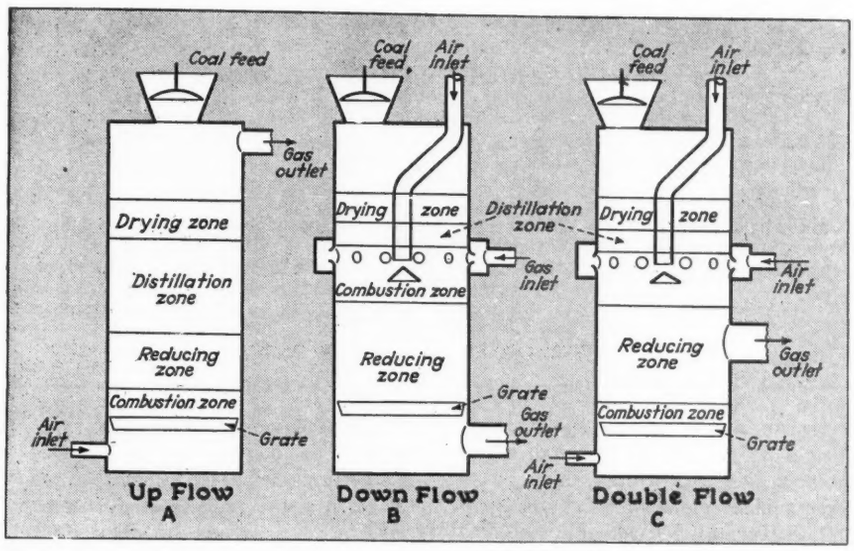



Fig. 2—Three major producer types: upflow, downflow, double flow

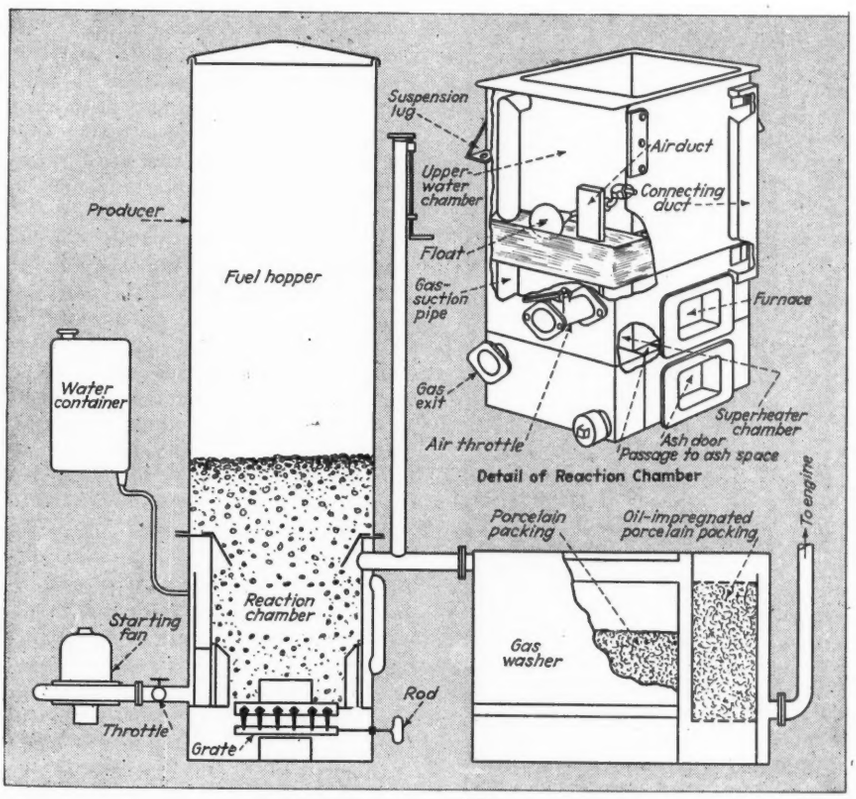



Fig. 3—Typical 1938-model producer

A coal- or coke-burning portable plant must carry about 90 lb of scrubber water per 100 miles.

Average producer gas contains 20-30% carbon monoxide, 5-18% hydrogen, a small amount of methane (usually about 1%), about 5% carbon dioxide and mechanical impurities, such as water vapor or condensate, acids, dust and sometimes tar. The rest is mostly nitrogen. Apart from the nature of the fuel, the composition and heating value of the gas are affected by producer design, air saturation, height of fuel bed, temperature and rate of gasification.

Fig. 2 shows diagrammatically three types of producers, and Table II gives data on each. For automotive and small stationary purposes up to about 150 hp, simple updraft generators are preferred; medium sizes have hand-operated revolving grates, and large producers are equipped with mechanically-driven rotating grates. Stationary producers are occasionally of the pressure type, while automotive units are always of the suction type.

## Typical Producer Unit

A 1938-model wood-charcoal or peat-coke burning plant is illustrated in Fig. 3. The producer is in two parts, connected by flanges. The upper section serves as a fuel hopper while the lower houses the reaction chamber, shown in detail. The outer jacket also contains two compartments; the upper is filled to a given level with water, while the lower one acts as a superheater. Air enters through throttle and duct, is partly saturated with water and heated and passes into the superheater chamber for further heating. The air-vapor mixture moves through the grate, which can be agitated by the rod, and enters the fire zone. The producer shell is protected against the intense heat by a refractory lining and by the water jacket.

Gas leaving the producer goes to the washer shown in detail in Fig. 4. Following the path indicated by arrows, gas is deflected by the baffle through the water space (in which level is maintained a few inches above perforated plate by test cock) and rises through a layer of cork granules (for charcoal gas) or saddle-type porcelain packing (for peat-coke gas) carried on the perforated plate. Gas then passes through the perforated pipe to the fine-filter chamber which contains ½-in. ceramic fillers wetted by a special oil. Residual condensate from the gas may be collected below the lower perforated plate.

With anthracite or bituminous carbonization coke as fuels, general producer design remains unchanged,

although properties of ashes or clinkers may influence choice of refractory. Gas cleaning is more elaborate, however, with gas first entering a dry cyclone to catch large particles. The washer works on the same principle as that in Fig. 4 but has a more ample water supply and a more liberally proportioned fine filter.

Where preference is given to lignitic carbonization cokes, the producer is fitted with a cast-iron cone which prevents ash from clinging to producer walls. With high-ash fuel of this type, more continuous operation of the grate, either by hand or motor, may be required.

As a rule, the standard engine in existing vehicles can be retained in wood-gas operation. New units designed for gas operation have more generously proportioned engines running at 1500 to 2000 rpm and featuring a compression ratio of 1:9 or 1:10 instead of the 1:6 ratio usual in gasoline operation. Operating on wood gas, a gasoline engine will furnish only about $\frac{2}{3}$ of its rated power because of the lower calorific value (65-70 Btu per cu ft). This figure can be raised to 80% or more by increasing compression through use of higher pistons or by reduction of height of cylinder head.

Producer equipment for marine use resembles that for stationary plants. Coal, coke, and wood have been applied with success on tugs and ferries in mining centers and harbors. Weight of fuel is not so important a factor as in road plant, and water for scrubber operation is available in unlimited quantities, which means that fuels with some sulphur content can be used. Compared to diesel craft, more space must be allowed for gas engines, producer, and bunkers, which means increased weight and cost. On the other hand, reduced fuel cost may yield a total saving of about 10%, with, say, 3000 annual service hours. In marine plants, ash and clinker removal is frequently automatic, and the trend is to make the plant self-acting in regard to fuel supply, adjustment of air-gas ratio, and of fire-zone level. Gas pressure is kept constant by a membrane-type governor; excess gas is blown to the air and ignited. A decided advantage of producer units is that automatization is simpler than with steam machinery.

Marine engines are usually 4-cycle vertical units, with attached water pumps and auxiliaries. The starting blower may be driven by a separate motor. The number of cylinders must suffice to ensure instantaneous starting. Average consumption of auxiliaries amounts to about 3%. Waste heat from engines is sometimes recovered to generate steam for auxiliary engines or for heating.

Stationary and marine plant is usually started by compressed air. Automotive units may be started on gasoline; a special manifold is used.

A common disturbance in stationary operation is caused by carbon residue from excessive cylinder lubrication. Excessive cylinder wall cooling causes trouble also, as condensation products are formed which later fall off and get incandescent; this makes the engine

(*Continued on page* 134)

TABLE I — FUELS FOR PRODUCERS

| *Fuel* | *Anthracite* | *Lignite* | *Bituminous Carb. Coke* | *Lignitic Carb. Coke* | *Peat* | *Charcoal* | *Wood* |
|---|---|---|---|---|---|---|---|
| Avg natural moisture, % | 2–4 | 50–60 | None | ..... | 80–90 | ..... | 40–50 |
| Avg moisture, "Dry" condition, % | 2–4 | 12–18 | 3 | 3–4 | 25–30 | 5–7 | 15–20 |
| Optimum size, in..... | 0.3–0.6 | 0.5–1.0 | 0.4–0.8 | 1.5–2.0 | 3.0– | 1.0–2.5 | 2.58 |
| Sulphur, %..... | 1–1.5 | 1–3 | 0.5–1 | 2.5 | 0.2 | 0.3 | 0 |
| Ash, %..... | 7 | 10 | 8–10 | 10–20 | 6–10 | 1–1.5 | 1–2 |
| Avg htg value, Btu per lb | 14,000 | 4,000 | 12,000 | 6,500 | 5,500 | 13,000 | 6,000 |
| Weight, lb per cu yd.... | 1,400 | 1,300 | 900 | 900 | 640 | 500 | 600 |
| Consumption, lb per hp hr | 0.8–0.9 | 3–4 | 1 | 1 | 2.5–3 | 1 | 2–2.3 |
| Preferable producer type | A | B,C | A | A | A,B,C | A | B,C |
| Gas cleaner..... | Wet | Wet | Wet | Wet, duplex | Wet or dry | Wet or dry | Dry |
| Preferred use..... | Stat, Marine | Stat, Rail | Stat, Trucks | Stat | Stat | Trucks Rail | Trucks Marine |

TABLE II — PRODUCER CHARACTERISTICS

| *Producer Type* | *Upflow* | *Downflow* | *Double Flow* |
|---|---|---|---|
| Permissible tar content in fuel.. | Low..... | Medium..... | High |
| Addition of water vapor into producer..... | Usual..... | Less usual..... | None |
| Accessibility of grate in service.. | Perfect..... | None..... | None |
| Required tightness of top cover.. | Must be tight..... | Need not be tight | Need not be tight |
| Temperature of exit gas..... | Moderate..... | Hot..... | Hot |
| General features..... | Gas preheats fuel — evaporation in fire zone | Extra-large gas cooler required | Total height of producer greatest—requires careful attendance — gas quality good |

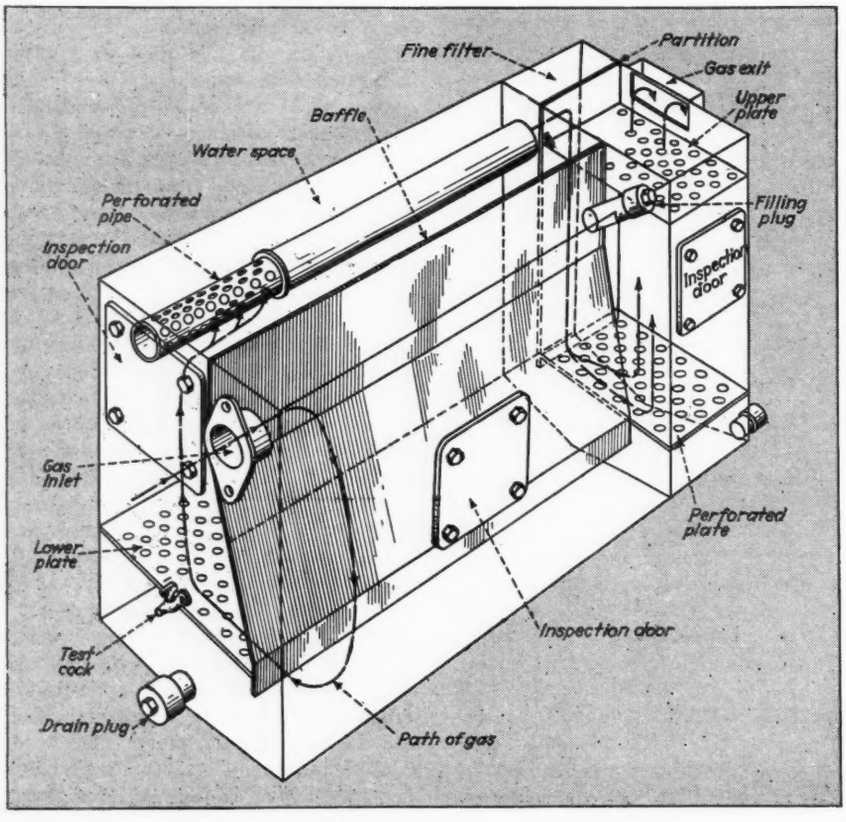
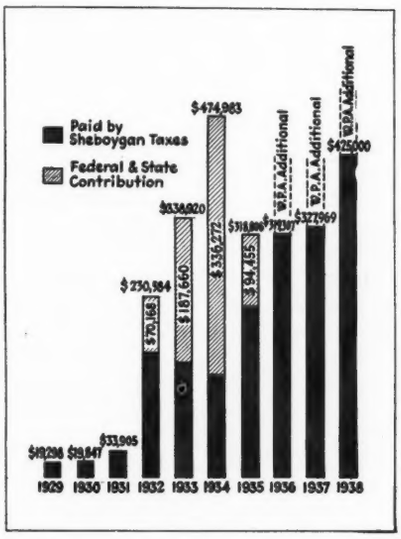



Fig. 4—Gas scrubber for portable producer in Fig. 3

# Work is Cheaper than Relief

PUBLIC RELATIONS for POWER MEN

*Sheboygan promotes local industries to solve relief problem, setting an example for engineer-citizens everywhere*




Local taxes paid $19,298 for relief in 1929, $425,000 in 1938

FIFTY MILES NORTH of Milwaukee, on Lake Michigan, lies Sheboygan. Just another typical American city—40,000 people getting along, or trying to get along.

That Sheboygan has a serious relief problem is no news; most American communities are in the same boat. But it *is* news that the citizens of this Wisconsin city, led by Willard M Sonnenburg, their MD mayor, are now working together as a unit to slash mounting relief costs without in any way penalizing the families on relief.

Accompanied by his Public Relations Counsel, Robert A Saltzstein, Mayor Sonnenburg recently journeyed to New York to tell his story to a group of McGraw-Hill editors. It is so interesting in its implications for other American towns and cities that we pass it along here, in brief, as a tip to the many power engineers who are also leaders in community affairs. Sentiment everywhere in America is to "do something" about unemployment and relief. As an essentially practical man, the power engineer will be happy if he can offer definite suggestions.

Long before the turn of the century, Sheboygan became a manufacturing town, primarily engaged in converting the good timber of Wisconsin into good furniture. Gradually the timber thinned out. By 1920 local cabinet woods became scarce enough to penalize the makers of cheaper furniture many of whom moved South. Builders of better-grade furniture stayed on, but with them a growing body of unemployed workmen, including many skilled mechanics.

Then came the depression to finish the job. From 1932 to 1935 the unemployment figure hovered around 4000. In the best months of 1936-1937 it was down to 2000, but climbed again to 3000 by Dec, 1938.

As Mayor Sonnenburg sees it, the 3000 is less cause for worry than the 2000. One is obviously the result of national depression, but the other acts like a permanent local situation—a perpetual burden on taxpayers and a chronic sickness of the body politic.

### The Record

Let's look at the record. In 1928 the tax rate was $31.38, including 45 cents for relief. By 1933, after a voluntary salary cut for city employees, the rate had dropped to $23.48, but $3.58 of this went for relief. In 1937, relief had mounted to $9.04 out of $37.46, including the amount required to pay the previous year's delinquency. In 1938, relief was down a little to $7.07 out of $33.75.

Putting this whole business in total dollars rather than in tax rates, the bar chart tells the sad story. Sheboygan spent $19,298 for relief in 1929. In 1938, the city spent $425,000 and the WPA additional unnamed sums. Last summer Mayor Sonnenburg decided to face the music. "It costs us $550 a year," he said, "to take care of each family on relief and all we do is to perpetuate the situation. We can't lower the cost of relief per family—it is at a subsistence level now. We can't rely on the Federal Government to pull us out of this thing. We as a city must do it. Money we spend for relief must be spent to give men jobs."

On August 29, 1938, was formed the Sheboygan Community Peace Board. A committee representing labor and business organizations quietly met to discuss ways and means. The men appointed were selected for their known fairness, perspective and community prestige. Labor men and business men came to see each other as human beings. They became enthusiastic about the slogan "Cooperation for Understanding." A highly-successful "radio town meeting" put the whole community solidly behind the project.

On August 31 the Sheboygan New Industries Council was organized to revitalize the city. For the first time it harnessed together all organizations having anything to do with developing and attracting new industries and expanding established local concerns.

Sheboygan has not yet solved her problem of permanent unemployment, but is on her way. The New Industries Council is seeking undeveloped products that the diversified industries of Sheboygan could produce commercially with the local German-Dutch skilled type of labor. Meanwhile Sheboygan is negotiating with the WPA for a complete analytical unemployment survey of the city.

In promoting the movement of certain outside industries to Sheboygan, the mayor says he does not intend to "rob Peter to pay Paul". He seeks no industry which does not plan, in any case, to move. He seeks none which is not naturally suited to the economic environment of Sheboygan. To those that fit the situation he is willing to offer special inducement, but not that of "cheap labor".

So far we see in Sheboygan a problem faced, cooperation achieved, action started. The final results will be awaited with interest by communities all over the country.

# Boiler-House Accessibility

*Practical ideas for platform design, most of which can be applied to any boiler, help a lot in maintaining vital equipment*

By JOSEPH ELMAN
*Structural Engineer, H M Wilson Co*

WE USED TO GET a big kick out of the story of the man who built a boat in his cellar before he discovered to his dismay that it required a major operation on the building to remove the product of his labor. That was before we found out that a boiler was a bricked-in steel shell, bounded on four sides by immovable stone walls, one of which occasionally had to be chopped out to remove a defunct boiler tube.

In many cases, we are still living in the dark ages of power-plant housing. Consider the condensers that are installed in inaccessible basements, and water-treatment apparatus that has outgrown its cramped surroundings. Boiler-feed pumps and other vital equipment are still being serviced in rubber boots, with flashlight in hand. Flying belts and exposed conveyor chains are still taking their deadly toll of life and limb in the darkness of catacomb-like alleyways and cellars.

When we realize how important accessibility and cleanliness are to proper maintenance of vital equipment we wonder why owners and operators are willing to put up with such old-fashioned methods year after year to the detriment of both operating efficiency and maintenance.

In order to show what can be done at comparatively little expense toward providing convenient means for reaching every part of the boiler, we have herewith set down some practical ideas for platform design, many of which can be applied to almost any boiler.

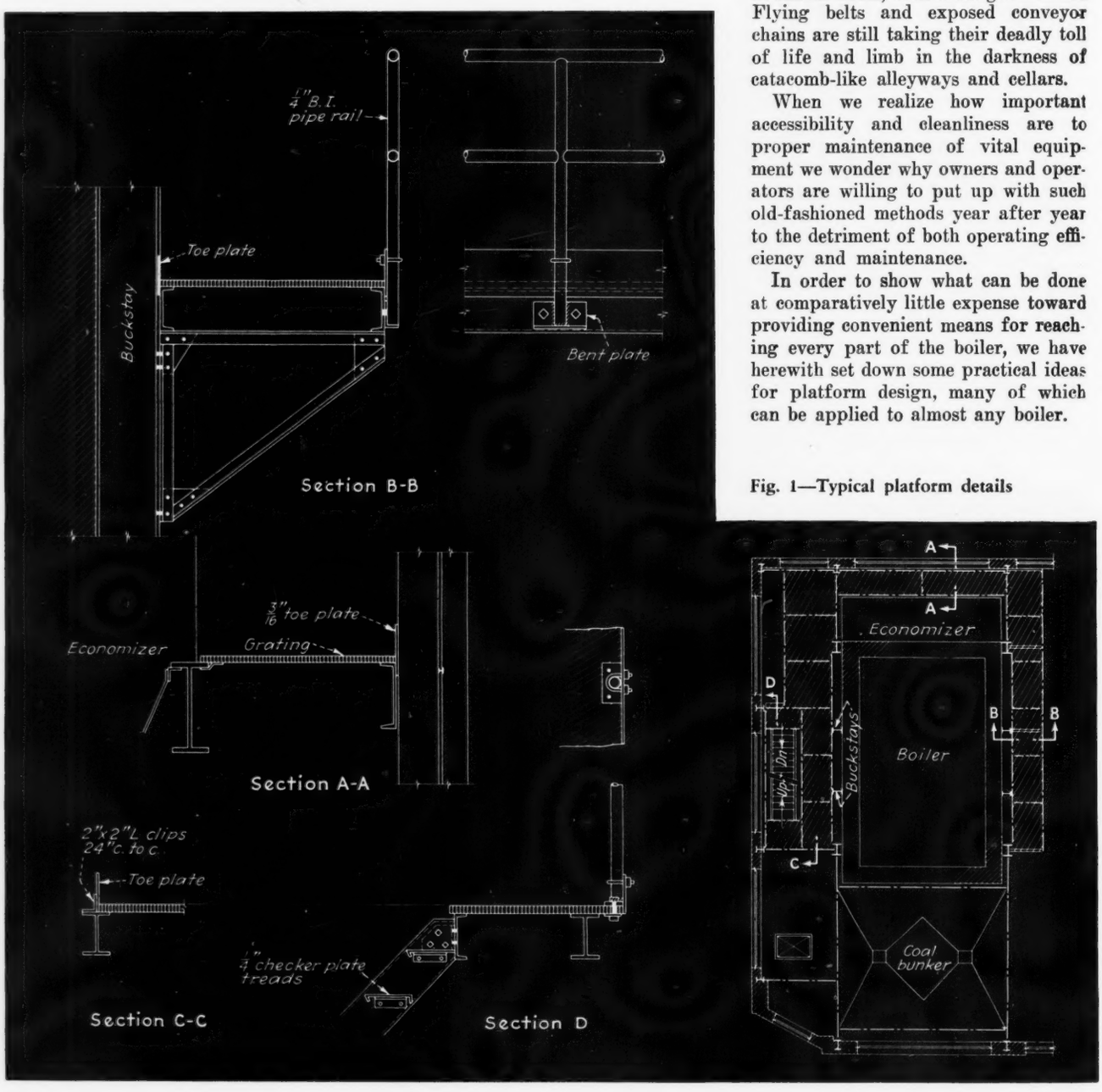



Fig. 1—Typical platform details

In general, platform levels should serve the following: access to the lower drum, observation and access doors, soot-blower heads, feedwater regulator, uptake damper and damper-operating mechanism, instruments, tube-removal doors, water column and superheater. These platforms should also make it convenient to operate and service important valves, piping, separators, desuperheaters, etc.

A well-planned system of platforms will give access to the top of boilers, bunker level and coal machinery, and will be the means for reaching the roof of the boiler and induced-draft-fan level if same is above the boiler. All of the above items, if not convenient to the operator, are apt to be neglected, with danger of breakdown.

Fig. 1 is a plan view of a typical boiler with platform framing on 3 sides. Wherever possible, a stair system should be provided in preference to ladders, especially on high boiler settings. The slope of stairs should not exceed 45 deg if possible, and should have some form of non-slip tread.

Steel gratings are universally used as flooring for platforms because they are economical, do not obstruct the light and can be installed to be easily removable. They provide a non-skid surface and permit free circulation of air around the boiler. When selecting sizes of gratings and supports, it should be remembered that they will at times be required to support valves, tools, and other heavy objects. In general, a design figure of 75 lb per sq ft live load will usually be sufficient to take care of these.

Unprotected sides and open areas should have pipe or angle handrails. Toe plates should be provided to prevent objects from falling off the edge to a lower level. City or State safety laws, if prevailing, should be consulted, but in general the details noted are equal to those of leading codes.

Platform beams should *not* be embedded in boiler brickwork, as expansion and contraction will result in serious cracks and loosening of the supporting bricks, and jeopardize the safety of the platforms. There is nearly always present sufficient steel, such as boiler columns and buckstays, to which beams can be safely connected.

Adequate lighting should be permanently installed at each platform, with switches conveniently located at the floor level so that they may be turned off when not in use.

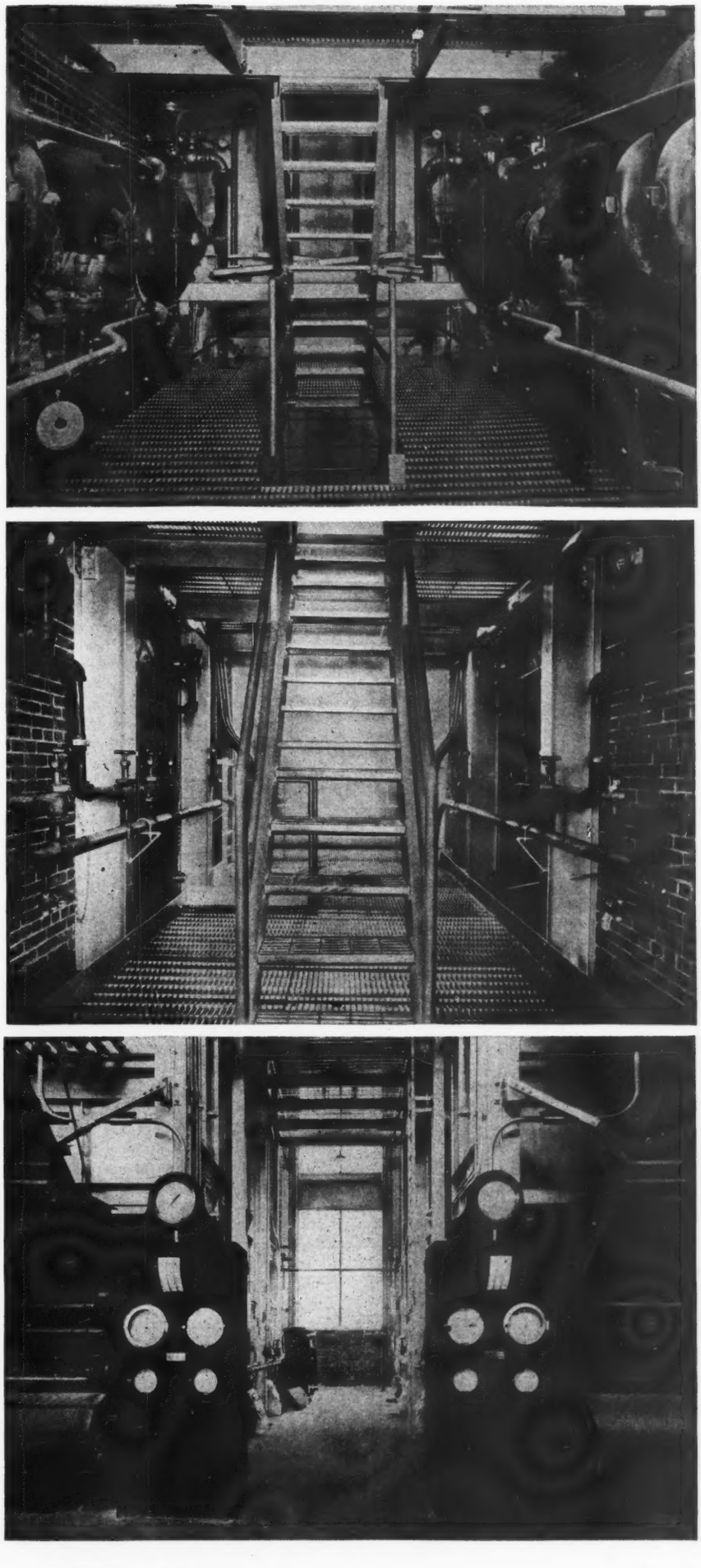


**Fig. 2—Example of desirable arrangement of platforms between boilers—2nd platform level at top, first platform level at center, and alley between boilers on firing floor at bottom**

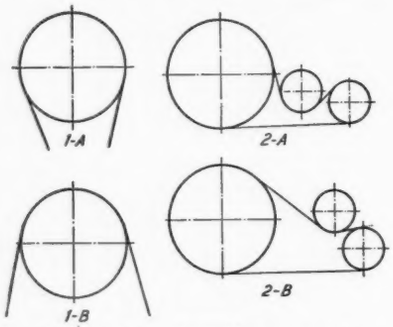
# Readers' Problems

## *Questions for Our Readers*

### Belt Flexing

*Question 1*

RECENTLY *I got into a discussion regarding the flexing of a belt running over pulleys. To put it in a nutshell, will the belt in 1-A flex more than that in 1-B, and will the belt in 2-A flex more than*




*Pulleys in Cases 1-A and 2-A are same as in Cases 1-B and 2-B, respectively*

*that in 2-B. The question only concerns flexing, with no consideration given to adhesion or hp delivered*—FG

### Feed Pump Trouble

*Question 2*

WE USE *a duplex pump to return condensate to boilers from a small reservoir to which traps return hot water. The reservoir is about 4 ft from the pump, and water level stays 5 or 6 ft below pump suction. Though repaired only a year ago, the pump now runs jerkily, even when the water-piston packing is changed. What is the matter?*—CAC

SUITABLE answers from readers will be paid for if space is available for publication.

### How Many Maintenance Men?

#### Answers to Question 1

*The Question*

AS HEAD *of the electrical-maintenance department of a large industrial plant, I would like to secure information as to how personnel requirements of such a department are estimated. I understand that there are various "yardsticks" for making such estimates, but am not familiar with them. I feel that I have an efficient organization, but am frequently confronted with the statement that the personnel of the electrical department should be some certain number for a given rate of production. These estimates are invariably too low, but without authoritative data I am at a loss to rafute them.*—LNB

### Make a Time Study

PRACTICALLY every industrial-plant electrical-maintenance foreman is confronted with LNB'S problem in these days of erratic production schedules. With management and the accounting division chopping costs to meet competition, it is natural that so-called non-productive departments should get the heaviest fire. Management brass hats are almost always men who have come up through production departments and so are obsessed with the production man's point of view—"so many machines running, so many operators and repair men required".

This is all very well until somebody tries to apply the same reasoning to personnel requirements of power-service and maintenance departments where an entirely different condition exists. Then the foreman, if equipment is to be kept in condition, must sell management the idea that electrical devices depreciate just as fast and sometimes faster when out of service as when running. This means keeping nearly a constant number of maintenance men whether the plant is operating at full or half capacity.

If personnel must vary for financial reasons, and added costs of deferred maintenance are absorbed during heavy production periods, the foreman must then use his own judgment in determining what personnel is required at various capacities. Minimum requirements will vary with plant type, age, design of electrical-service equipment, and whether variations in capacity are absorbed by shutting down part of the plant or by changing working hours. It seems to me that no single yardstick could be developed to take into consideration all these factors, and a formula must be worked out for each plant.

One method of working out such a formula, that will be acceptable both to management and the electrical department supervision, is to make a time study of the work done by members of the maintenance group, at different rates of plant output. The results, corrected for any obvious departures from recognized maintenance procedure, can be formularized. It has been my experience that a joint study made by the foreman and a representative of the costing division will usually react in the electrical department's favor and in the long run contribute substantially toward reducing over-all maintenance costs.

*Roanoke, Va.* S H COLEMAN

### Depends on Equipment

THE YARDSTICK that determines personnel requirements of a maintenance department is the care with which motors, controls and similar equipment are selected, installed, and watched over. If equipment is not properly motorized, and if motors aren't properly protected, maintenance costs are likely to be high.

MANY STATES have adopted boiler codes based, in most cases, on the ASME Boiler Construction Code. By formulating experience and known facts, these codes promote safe boiler-plant operation. They will work most effectively if they are understood as well as followed. Printed below is a paragraph from the ASME Code. Read it, and consider the reasons for the rule. Then turn to page 132 and check your thinking with the discussion given there.

### SAFETY-VALVE ADJUSTMENT

P-285a: "The spring in a safety valve in service for pressure up to and including 250 lb shall not be used for any pressure more than 10% above or 10% below that for which it was designed. For higher pressures the spring shall not be used for any pressure more than 5% above or 5% below that for which it was designed.

b: "If the operating conditions of a valve are changed so as to require a new spring under (a) for a different pressure, the valve shall be adjusted by the manufacturer or his authorized representative who shall furnish and install a new name plate as required under P-273."

---

In every plant there are places where conditions are not of the best for operation of electrical equipment, but today it is possible to select motors and controls for practically any service. It goes without saying that electrical equipment requires more frequent inspection and greater care where operating conditions are not of the best.

In our plant, we have found that regular inspection, in conjunction with regular oiling, keeps us pretty well in touch with our motors and control equipment and if any unusual condition is noticed it can be checked immediately. With a total of 785 motors ranging from fractional hp to 50 hp, mostly of the loom type in ½-hp, ¾-hp and 1-hp sizes, we employ but one man in our electrical department. Coil repairs and rewinding are done outside, since it wouldn't pay to put in the necessary equipment to do it ourselves. We do all our own installation work for light and power, using a helper from another department, if needed for heavy work. Our accumulated average cost from 1918 to 1937, for coil repairs and rewinding, has been $0.246 per motor per year.

*Ansonia, Conn.* W T ESTLICK

## Heating-System Water

### Answers to Question 2

*The Question*

I WOULD *like to know what* POWER *readers think of emptying and refilling a hot-water heating system each year. Some engineers I have talked to say not to empty the system, and recommend using the same water year after year. Others are of the opinion that water should be changed yearly*—JAD

### Use Rust Inhibitor

WHERE WATER is hard or of a nature to form scale, it is advantageous to use the same water year after year. This also applies to water containing dissolved oxygen, carbon dioxide, or other corrosive gas. On the other hand, a change of water allows freer maintenance work on the equipment.

Objections to renewing water can be overcome by using a rust inhibitor such as crystallized sodium dichromate. Where organic matter or dissolved oxygen is present, the first action of these substances is on the dichromate. Therefore the amount of dichromate to use varies with the water composition. Enough should be added to give an analysis of 0.13 to 0.14. For ordinary soft water, this requires about 1⅛ ounces per cu ft of water. The amount of caustic should be carried to a pH of about 8.5. This corresponds to 0.037 NaOH, or about ½ ounce per cu ft.

Use of the inhibitor keeps the metal clean and the water free from insoluble matter. It does not act on valve or trap parts; but where aluminum is used on radiator connections, the caustic should not be allowed to build the pH above 8.5. If stronger, there is possibility of action on the aluminum.

*Lakewood, Ohio* J P SIMONS

### Draining Lets in Air

APART from possible maintenance or replacement work, JAD probably drains the system in summer to reduce rusting. In my experience, such a plan is more apt to encourage rather than prevent corrosion. Water, impurities, and air cause the trouble, but water is a necessary part of the system and impurities exist in all but chemically pure water. Air can be readily excluded. After draining, air replaces the water, with droplets of water remaining to encourage rust formation. When the system is refilled, much "tramp" air is trapped in the system, under rust flakes, in recesses of fittings, in high spots of pipes, and frequently as a thin film on pipe walls.

All this tramp air must be bled off, gradually worked upward to the expansion tank, vented through air-relief valves in radiators before the system again reaches the practically air-free condition it had before draining. The writer knows personally of several large apartment houses, hot-water heated, where the systems have not been drained in 10, 8, and 7 years respectively. The only change has been addition of small quantities of water to make up for evaporation and leakage losses.

Rust formation in these systems was checked by draining a small quantity of water from near the base of the heating unit, while in operation. Samples were as clear as fresh water drawn from a supply tap. The effectiveness of this test comes from the fact that water circulating through the system tends to pick up tiny rust flakes and to carry them to the base of the heater. Centrifuging a sample from the base will indicate the amount of rust carried.

Unless JAD'S system has been drained so often that rust conditions demand drainage for cleaning and repair, I'd counsel maintenance of all year-around operating level in the system and careful guarding of the supply made air-free by a season's circulation while hot.

*Kilgore, Texas* C C LYNDE

### Check Condition Yearly

I ALWAYS recommend checking condition of the water each year. If there is an accumulation of sediment in the bottom of the boiler, enough water should be drawn off to remove it. Sometimes active pitting can be taking place when such a condition exists, and if sludge piles up sufficiently, circulation will be impaired. After sludge has been removed, enough fresh water can be added to make up for what has been drawn out. If the water in the system is clean, I see no reason for draining. It is oxygen free and is to be preferred to fresh water that may have oxygen in it.

*Ansonia, Conn.* W T ESTLICK

### Draining Unnecessary

YEARLY emptying and refilling of a hot-water heating system is an unnecessary operation and expense which may well be avoided except when absolutely necessary for repairs to the system. Even when making repairs, no more water should be withdrawn than is required to lower the water line below the working point.

When a hot-water heating system is freshly filled, dissolved oxygen in the water immediately sets up a strong corrosive action, the peak of which is reached with water at its highest temperature. This process, generally known as the electrochemical cycle of corrosion, causes particles of iron from the pipe surfaces to go into solution as iron ions, displacing hydrogen ions from the solution and depositing them as a hydrogen film on system surfaces. Protection afforded by this film is short lived, for turbulence of water flowing disturbs it and hydrogen is either vented as a gas or combines with some of the dissolved oxygen in the water. Removal of film permits more iron to be drawn into solution, displacing more hydrogen ions and also other iron ions, which latter combine with dissolved oxygen and water to form insoluble ferric hydroxide (iron rust) which precipitates.

Gradually, dissolved oxygen in water is eliminated and corrosion is arrested. With this in mind, it doesn't seem good practice to drain and refill. While only iron has been mentioned in the above discussion, oxygen will attack any metal to varying degrees.

A ready illustration of the effect of fresh water on piping systems is easily at hand for observation. In thousands of residences in all parts of the country, there are hot-water heating systems alongside of domestic hot-water systems. In most cases the heating system will be found to last as long as half a dozen domestic water systems. This is due to the fact that loss of water from a heating system is negligible in the long run, but in a domestic water system, fresh water is constantly added to make up for water used.

*Richmond, Va.* R P HANKINS

### Depends on Conditions

IF JAD'S HEATING system was originally filled with distilled water and all later additions were with distilled water, it would not be advisable to drain the system each year. Only a small amount of sediment would collect and there would be no need for draining. If originally filled with impure water, with later similar additions containing calcium and magnesium salts, the system should be drained and it would be a good plan to refill with distilled water.

Where water has been chemically treated to keep impurities in solution, it seems advisable to drain the system at intervals. If this is not done, impurities in solution would build up in concentration, depending on the system and the rate of makeup.

*Bismarck, N. D.* LESLIE BRADLEY

### Draining Is Waste of Effort

JAD'S QUESTION is complicated by a number of controversial factors, some of which are likely to be given more importance than they deserve. Personally, I am opposed to emptying and refilling heating systems, not so much for the accepted reasons but simply because it means an unnecessary waste of water and effort.

Among the overrated effects charged against periodically draining systems are: (1) corrosion due to air coming in contact with wet metal exposed during the time between draining and filling. When no more than a few hours are involved this is a negligible factor, but exposure for longer periods should be avoided. (2) Corrosion from free and dissolved gases in the fresh water. Where water is changed infrequently, effects of these gases can be ignored. Free gases will tend to accumulate in radiators, however, interfering with effectiveness of heat emission and must be bled off through manually operated vent valves.

In extensive systems requiring fresh water makeup, to compensate for leak-

(*Continued on page* 128)

# Power Lines

## Construction Begun On Oswego Steam Station

General contract for construction of the new $9,500,000 Oswego Steam Electric Station has been awarded to Stone & Webster Engrg Corp of Boston and New York. According to the schedule under which the contractors are operating, the structure will be ready to receive the first unit of equipment by midsummer, 1939.

An interesting feature will be construction of the intake which will supply water to the plant. This will be tunneled out of solid rock, and will extend under the Oswego harbor and out into the lake approximately 700 ft.

Contracts for the 80,000-kw turbine-generator, the largest purchase of its kind by the utility industry in the past seven years, were let August 16 to the General Electric Co. Babcock & Wilcox Co was awarded the contract for the boiler on August 15. The contract with the builder of the boiler calls for commencement of delivery by midsummer, 1939, while it must be completely erected and ready for the drying-out fires early in 1940.

## ASME Spring Meeting At New Orleans, Feb 23–25

The tentative program announced for the 1929 Spring Meeting of the American Society of Mechanical Engineers, to be held at New Orleans, La., Feb 23-25, promises to be one of the most practical and informative ever arranged, from the standpoint of the power engineer. Sessions will cover waste fuels, boiler feedwater, power, and fuels.

*Waste-Fuels Symposium*

"Burning Oat Hulls," C J Herbeck, Ch Engr, Iowa Elec Light & Power Co. "Burning of Pulp Mill Waste from a Sulphite Mill," Grover Keeth, Marathon Paper Mills Co, Rothschild, Wis. "Burning Various Types of Oil Refinery Fuels," A L Wilson, Standard Oil Co of N. J., Bayway Refinery. "Combustion of Wood Waste Fuels," Henry Kreisinger, Combustion Engrg Co, N. Y. "Burning Bagasse," E W Kerr, Consulting Engr, Baton Rouge, La. "Byproduct Fuels in the Steel Industry," Gordon Fox and W B Clemmitt, Freyn Engrg Co, Chicago, Ill.

*Boiler-Feedwater Studies*

"Grooving of Tubes in High Pressure Boilers," R E Hall and E P Partridge, Hall Laboratories, Pittsburgh, Pa. "Mechanical Purification of Steam within the Boiler Drum," M D Baker, Chemist, West Penn Power Co, Springdale, Pa. "Corrosion in Partially Dry Generating Tubes," Prof F G Straub, Univ. of Ill.

*Power*

"Economics of Power Plants for Joint Utility and Industrial Service," A C Klein, Chief M. E., Stone & Webster Engrg Corp, and Thomas E Crossan, Supt, Louisiana Station, Gulf States Utilities Co. "Development of Power and Steam for Oil Refinery Service," C E Steinbeck, Engr, Pacific Gas & Elec Co, San Francisco. "Mountain Creek Steam Electric Station—An example of Semi-Outdoor Construction," Harry R Pearson, Engr, Dallas Power & Light.

*Fuels*

"Lignite—A Grate-Fired Fuel of the Future in the South West," Prof C J Eckhardt, Jr, University of Texas. "Burning Modern Bunker Fuel Oils," J A Hayes, Todd Combustion Equipment Inc, N. Y. "Pulverized Coal Tar Pitch as a Fuel," E W Clarke, Ch Engr, Tar & Chem Div, Koppers Co, Pittsburgh.

## Fuel Conference

Appalachian Coals, Inc, Cincinnati, Ohio, carrying on its series of fuel-engineering conferences for the fifth consecutive year, was host to 326 fuel and power engineers, industrial executives, purchasing agents, researchers, coal company representatives and railroad coal traffic men on Dec 13 at Kalamazoo, Mich. Those who attended the conference came from 35 Michigan cities and 17 out-of-state municipalities. They represented eight states—Illinois, Indiana, Michigan, Ohio, New York, Pennsylvania, Tennessee and Virginia—the District of Columbia and Ontario, Canada.

Papers presented at the conference included "The Modern Small Power Plant," by H L Solberg, professor of mechanical engineering, Purdue University; "Combustion Practices and Experiences with Underfeed Stokers," by G G Zimmerman, test engineer, Indiana Service Corp, Ft. Wayne, Ind.; "Engineering in the Small Stoker Industry", by E C Webb, engineering service manager, Iron Fireman Mfg Co; "Some Fundamentals of Smoke Abatement", by J F Barkely, supervising engineer, Fuel Economy Service, U. S. Bureau of Mines; and "Combustion of Pulverized Coal", illustrated with colored motion pictures, by E G Bailey, vice-president, The Babcock & Wilcox Co.

An article based on information presented by Professor Solberg at this meeting, will be published in an early issue of POWER.

## Meetings

**American Society of Mechanical Engineers**—*Spring Meeting, Feb 23–25, St. Charles Hotel, New Orleans, La. C E Davies, secretary, 29 W 39th St, New York, N. Y. Concurrently, there will be held the annual meeting of the Louisiana Engineering Society.*

**American Society of Refrigerating Engineers**—*26th Spring Meeting, May 22–23, Hotel Hershey, Hershey, Pa. Headquarters office, 37 W 39th St, New York, N. Y.*

**National District Heating Association**—*Annual Meeting, June 27–30, Hotel Pennsylvania, New York, N. Y. W H Sanford, secretary, 1317 Spruce St, Philadelphia, Pa.*

## Utilities Announce Expansion Programs for 1939

Two utility companies broke first ice in 1939 by announcing expansion programs last month. Public Service Corp of New Jersey approved an expenditure of $23,500,000 for improvements of plants and equipment, and extension of gas and electric facilities.

Largest item in the program will be erection of a 100,000-kw turbine-generator and two boilers at Burlington generating station, to be placed in operation in 1941. It will cost, including extensions to turbine and boiler rooms, approximately $12,000,000.

Consolidated Gas, Electric Light & Power Co of Baltimore has recently let contracts for equipment to top a portion of its Westport station. The installation will consist of two Combustion Engineering, high-pressure, 3-drum, bent-tube boilers supplying steam at 1325 lb, 915 F at the superheater outlet, to a 25,000-kw General Electric turbine-generator exhausting to present 200-lb turbines.

It was stated that the new steam generating units will be designed for a maximum rating of 313,000 lb of steam per hr, with feedwater at 330 F, or 330,000 lb with feedwater at 383 F.

Each unit will be fired by four type-R horizontal turbulent burners receiving pulverized coal through independent feeders, from two CE-Raymond bowl mills. The furnaces will be completely water cooled and will have V-shape dry bottoms. Continuous fin-tube economizers and Ljungstrom air preheaters will be employed.

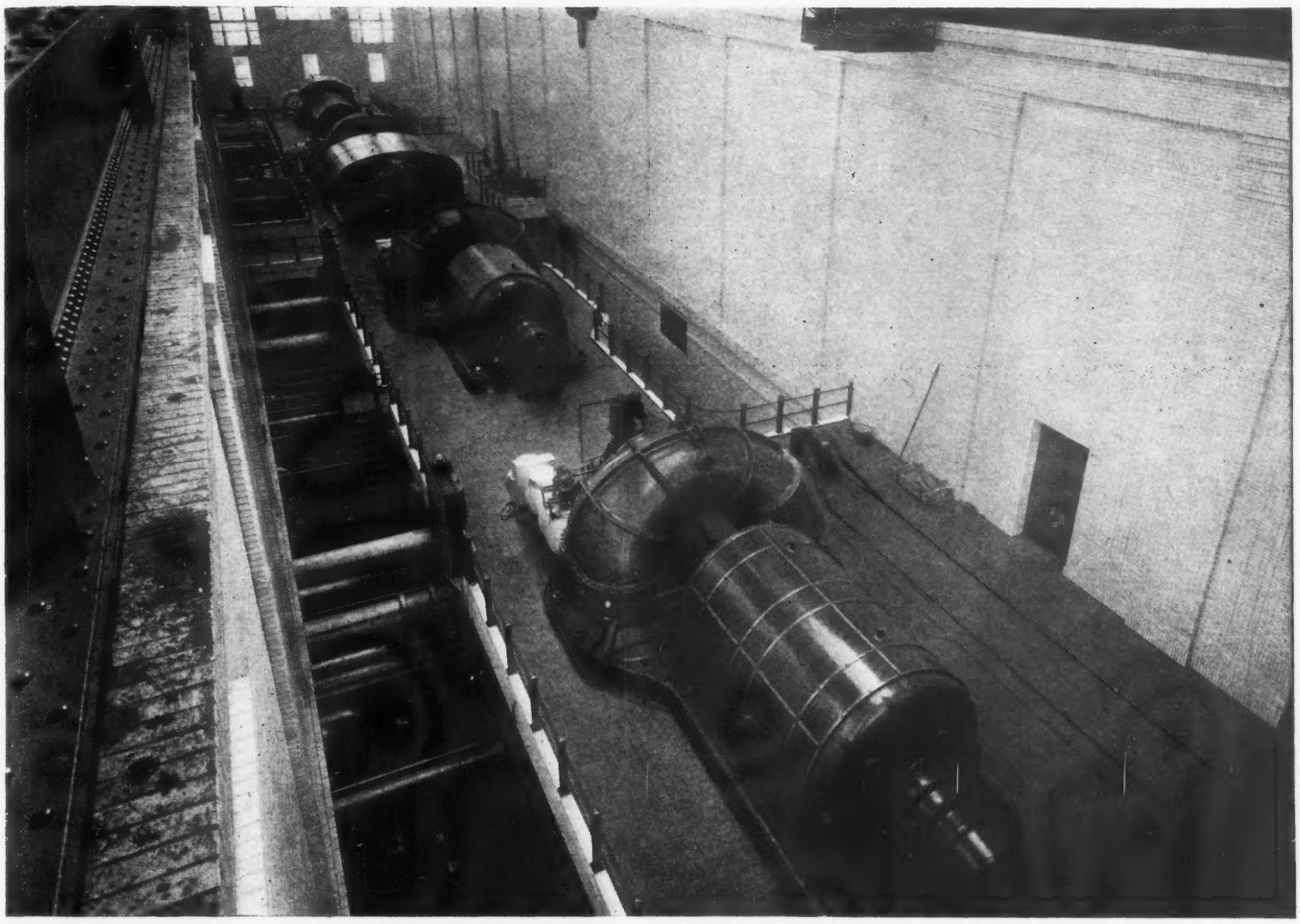
## Cleveland to Add Turbine

Cleveland recently approved a $3,000,000 bond issue to finance expansion of the city's light plant, which will include addition of a 37,500-kw turbine-generator.

At the present time, the city has 50,000 kw of generating capacity, which has not been increased since 1922. Present peak load is 42,500 kw, which is expected to be increased in the future. City engineers estimated that normal customer increase, plus pumping-station and sewage-plant demands, will increase load to 61,410 kw by 1942.

## OBITUARIES

PERCY C DAY, 63, vice-president and chief engineer of The Falk Corp, Milwaukee, Wis., died in December at his home in Elm Grove, Wis. Mr. Day came to the U. S. in 1910 from England, where he had been a power-plant engineer, and became associated immediately with Falk Corp. He was an inventor of numerous gear devices, transmissions, and drives for roller mills.



**LOOKING TURBINEWISE**

**Turbine room of Hartford Electric Light & Power Co's South Meadow Station, looking SW, contains two 20,000-kw (foreground) and two 40,000-kw units—recently installed turbine is at extreme end. Stone & Webster Engrg Corp acted as engineers and constructors for this addition, which besides the General Electric turbine, includes a 425,000-lb-per-hr B&W boiler supplying steam at 850 lb, 900 F**

E T KEEFE, president of Underground-Steam Construction Co, Boston, Mass., died in December at his home in Newton, Mass. For the past 15 years, Mr. Keefe had been president of this company, and previously, he carried on a similar engineering and contracting business under his own name.

L A SNIDER, well-known combustion engineer, died Dec 10. Mr. Snider was graduated from Rose Polytechnic Institute in 1905, and for many years conducted his consulting engineering firm in Indiana. In 1929 he was appointed consulting engineer for the State of Illinois, and in 1934 he joined Hoffman Combustion Engrg Co, Detroit, Mich. Recently, Mr Snider had become director of sales for Howell Engrg Co, St. Charles, Ill.

HOSEA WEBSTER, 79, who retired in 1933 as general sales manager of Babcock & Wilcox Co, New York, N. Y., died January 2, at his winter home in Coral Gables, Fla. Mr Webster, a graduate of Cornell University in 1880 and Stevens Institute of Technology in 1882, joined B&W in 1897. Before that, he had been with Henry R Worthington Hydraulic Works, Chicago, Ill.

## PERSONALS

ERIC A ROCKSTROM, engineer of maintenance at the U. S. Custom House, Boston, Mass., has become chief engineer of the Custom House and U. S. Appraiser's Stores Div, at Boston, with an advance of two ratings.

E W SEEGER has been made chief engineer of Cutler-Hammer, Inc, Milwaukee, Wis. Succeeding him as assistant chief engineer is P B Harwood, formerly general engineering supervisor. Mr Seeger became associated with Cutler-Hammer in 1913, shortly after receiving a degree from Ohio State University. In the next 15 years, he had considerable experience in shop and engineering departments, becoming assistant chief engineer in 1928. Mr Harwood, a Carnegie Tech graduate, has been with Cutler-Hammer since 1917.

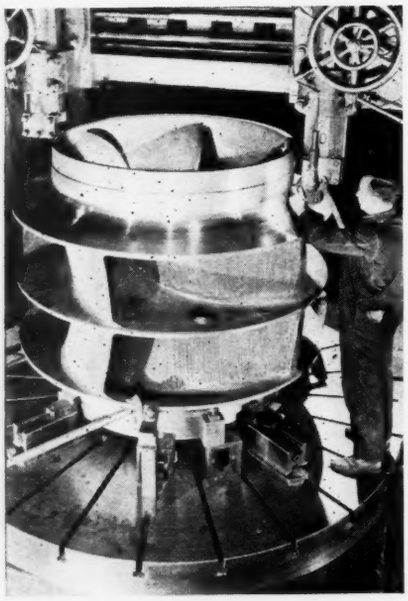
E W Seeger

JOHN M BIRKENSTOCK has been elected vice-president and general manager of The Green Fuel Economizer Co, Inc, Beacon, N. Y. Mr Birkenstock, a graduate of Stevens Institute of Technology in 1913, has been associated with the company as a sales engineer since 1924. He was previously employed by Babcock & Wilcox Co.

## BUSINESS ITEMS

EDWARD VALVE & MFG CO, East Chicago, Ind., has added the following representatives: W E Bowler, Witherspoon Bldg, Philadelphia, Pa.; and Frank W Hoyt, Waverly, Pa.

MONSANTO CHEMICAL CO, St. Louis, Mo., has promoted Victor E Williams, manager of its New York sales branch,



**SEWAGE PUSHERS**

**Four record-size, single-stage, double-suction centrifugal pumps now under construction for Chicago's Racine Ave Pumping Station, require giant, 14,000-lb revolving elements, like the one shown above on the boring mill at the Allis-Chalmers Mfg Co, Milwaukee, Wis. Each pump will deliver 375 cu ft per sec at 138.4 rpm against 19½ ft head**

to assistant general manager of sales. A T Loeffler, who has been assistant manager of the New York branch, succeeds Mr Williams. F C Renner, assistant general manager of sales, Merrimac Div of Monsanto, Boston, succeeds Mr Loeffler in New York.

THE OSBORN MFG CO, Cleveland, Ohio, has purchased the assets of the Johns Conveyor Corp, Newark, N. J., manufacturer of the Johns traveling conveyor. Manufacturing operations are now being moved to Cleveland, Ohio. Harry S Johns, inventor of the conveying system, will be chief engineer of the Johns Conveyor Div, Osborn Mfg Co.

FOOTE BROS GEAR & MACHINE CORP. Chicago, Ill., has appointed the following representatives: A C Andrews, 1613 Bryan St, Dallas, Tex.; W M Lee, 1409 California Ave, Houston, Tex.; and Industrial Engrg Co, Professional Bldg, Charleston, W. Va., as factory representative for southern W. Va.

## STRAWS

**Pointing the way business winds blow**

**CALIFORNIA**——State Prison Dept, Sacramento plans power house at new state prison at Chino. Entire project will cost about $3,500,000. Walker & Eisen, 437 South Hill St, Los Angeles, architects.

Los Angeles Brewing Co, 1910 Main St, Los Angeles, plans additions to plant for large increased capacity. Cost about $500,000 with machinery and power equipment. Proposed to carry out work in spring. L A Parker, company engineer.

Los Angeles County Housing Authority, Los Angeles, care of Public Adminis-

(*Continued on page* 136)

# NEW PLANT CONSTRUCTION

*McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service*

**Fla., Jacksonville**—A P W Co., D. G. W. Hollister, pres., Bridge St., Albany, N. Y., plans constructing paper manufacturing plant. To exceed $1,000,000. Private plans.

**Ga., Atlanta**—Montgomery Ward & Co., West Chicago and North Larabe Sts., plans constructing mail order house, Brookwood Sta. N.E. Property acquired. $3,000,000. Private plans.

**Ill., Rock Island**—International Harvester Co. plans modernization and expansion of tractor plant, incl. installing new machinery and constructing an addition. $5,000,000. Maturity 1939.

**Ind., Fort Wayne**—Bids Jan. 24, by Bd. P. Wks., R. G. Beams, chn., City Hall, improving light and power plant, high pressure water tube boiler, soot blower, combustion control equipment, stoker. $136,000. City Eng. Dpt., engrs.

**Ia., Akron**—Bids Feb. 14, by City, A. Manning, city clk., improving light plant.

**Ia., Anita**—City, S. A. Karns, clk., final plans in progress constructing light and power plant building, equipment, distribution system, etc. $170,500. PWA. Young & Stanley, Inc., Muscatine, engrs.

**Ia., New Hampton**—City plans alterations and improvements to light plant. S. R. Hunter, 6434 Eberhart St., Chicago, Ill., engr.

**Ia., Sioux City**—Sioux City Gas Electric Co., G. A. Neal, genl. mgr., plans improving plant, incl. boiler capable developing 725 lbs. pressure, turbine unit with 2,000 hp. generator, etc. $600,000.

**Kan., Waterville**—City approved $19,000 bonds for generating unit and constructing new power plant. $34,545. P.W.A. project. Paulette & Wilson, 1006 Kansas Ave., Topeka, engrs.

**Ky., Burkesville** — City making plans and takes bids soon constructing light, heat and power plant. $65,000. J. L. Watkins, McClelland Bldg., Lexington, engr.

**Ky., Louisville**—Jefferson Co., c/o M. Beauchamp, judge, plans constructing steam power plant and electric distribution system. $90,850. PWA allotted $40,883 grant. W. C. Wagner, 629 Breslin Bldg., engr.

**Ky., Nicholasville**—City, c/o W. R. Smith, mayor, plans constructing power plant addition. $85,000. PWA grant. J. S. Watkins, Citizens Bank Bldg., Lexington, engr.

**Md., Westport (sta. Baltimore)**—Consolidated Gas, Electric Light & Power Co., Lexington and Liberty Sts., ocnstructing electric generating plant addition. Owner builds. $3,600,000.

**Minn., Delano**—Village, c/o Water & Light Comn., O. B. Hildebrand, chn., making plans constructing 1 story, 26x45 ft. brick, concrete power house addition, 450 hp. boiler, etc. $50,000. G. M. Orr & Co., 542 Baker Arcade Bldg., Minneapolis, engrs.

**Mo., Lathrop**—City, c/o mayor, soon takes new bids constructing 1 story, 34x43 ft. rein.-con., brick power palnt, distribution system, street lights, accessories, etc. $75,000. E. T. Archer & Co., New England Bldg., Kansas City, Mo., engrs. Bids Dec. 19 unopened.

**Mo., Palmyra**—City plans by F. Beard, Kahoka, constructing municipal light and power plant with equipment, distribution lines, etc. $66,836. PWA allotted $30,000 grant.

**Mo., Sullivan**—PWA grant rescinded for power construction, for City. $125,000. W. A. Fuller & Co., 2916 Shenandoah Ave., St. Louis, Mo., engrs.

**N. J., Belleville**—Andrew Jergens Co., 2535 Spring Grove St., Cincinnati, O., plans constructing manufacturing plant. $1,000,000.

**N. Y., Perrysburg**—City plans repairing sewage disposal plant and power plant, J. N. Adam Memorial Hospital. To exceed $25,000. Architect and Engineer, c/o owner, T. J. Mungovan, chn. hospital com., c/o owner.

**N. Y., White Plains** — Bd. Supervs., Westchester Co., surveys completed, constructing 10 diesel engine electric power plants for lighting Westchester Co. parkways. $130,000. E. J. Kates, c/o owner, engr.

**N. C., Cliffside**—Duke Power Co., 430 South Church St., Charlotte, plans constructing 2 unit steam power plant, east of here. $7,500,000. Site selected. Will also build village of 40 houses for employees. Work to begin at very early date.

**N. D., Wahpeton**—Otter Tail Power Co., Fergus Falls, plans constructing power plant addition, installing 10,000 kw turbine. $400,000. Private plans

**O., St. Bernard**—City plans constructing electric plant. $28,060. PWA grant $12,627 approved. H. A. Nunlist, 1011 Traction Bldg., Cincinnati, engr.

**Okla., Tecumseh** — City plans constructing municipal power plant. $40,758. PWA project. H. H. Mahler, 515 Central Bank Bldg., Tulsa, engr.

**Ore., Astoria** — Columbia River Packers Assn., W. L. Thompson, chn. Bd., soon takes bids enlarging cold storage facilities and tuna canning plant at Astoria, also erecting tuna reduction plant on Skipanon River near Warrenton. $175,000.

**Pa., Cresson**—Commonwealth of Pennsylvania, A. F. Jones, acting ch. engr., Harrisburg, sketches completed by C. Blatchley, 985 Drexel Bldg., Phila., remodeling power plant at sanitarium, erecting radial brick stack, 125 ft. high, etc. $72,071.

**Pa., Lewisburg**—Citizen's Electric Co., J. M Grundy, dir., Lewisburg, plans survey, constructing modern light and power plant. To exceed $50,000. Engineer appointed soon.

**Tex., Manor**—City voted bonds constructing municipal electric light and power system. $65,000. PWA project. Power to come from LCRA. J. W. Beretta Engineers, Inc., c/o Natl. Bank Commerce, engrs.

**Tex., New Braunfels**—C. Shelby & Associates, c/o San Antonio Pub. Serv. Co., 201 North St. Marys St., San Antonio, sketches 5 story, basement, 180 x 260 ft. rein.-con., steel, knitting mill and hose factory. $1,000,000. Site purchased. Eng. Branch San Antonio Pub. Serv. Co., 201 North St. Marys St., San Antonio, engrs.

**Tex., Somerville**—City voted bonds constructing electric light, power distribution system. $45,000. PWA funds authorized.

**Wash., Chehalis**—Public Utility Dist. 1, soon takes bids furnishing 2 or 3 units, 45 to 60 hp. standard, high speed, direct connected Diesel generators. $31,000. REA allot. R. E. Towne, Perkins Bldg., Tacoma, engr.

**Wis., Boscobel** — Tri-State Power Cooperative, Boscobel, plans constructing generating plant. REA.

**Wis., Chippewa Falls**—Wisconsin Power Cooperative soon takes bids constructing additional unit to generating plant. $200,000 REA allot E. B. Wayts, supt.

**R. C. Cranbrooke**—Bids Jan. 24, by F. W. Burgess, city clk., constructing hydro-electric power plant on St. Marys River 10 mi. from here, also emergency stand by Diesel powered plant at Cranbrooke. Approximately $125,000.

**B. C., Vancouver**—Syndicate, c/o Mayor G. C. Miller, City Hall, plans nearing completion constructing artificial silk manufacturing plant. $300,000.

**Ont., Eganville**—Lloyd Deagle, making plans constructing extension to dam and power house. $30,000. Private plans.

**Ont., Gananoque**—Gananoque Light, Heat & Power Co., plans constructing power house and concrete dam, Rideau River. $35,000. J. McRae, Ottawa Electric Bldg., Ottawa, engr.

**Ont., Hamilton**—National Steel Car Corp., Ltd., R. J. Major, genl. mgr., 14 Kenilworth Ave., making plans constructing plant extension. $450,000.

**Quebec**—Province of Quebec, S. A. Baulne, chn., Quebec City, making plans hydro-electric power development at Chibougamau. Initial cost $500,000. National Electricity Syndicate, Parliament Bldgs., engrs.

**Que., Coaticook**—Municipality, R. Dumont, clk., making plans constructing electric power plant. $50,000.

**Que., Dixville**—Dixville Hydro-Electric Co., Ltd., 513 Rachel St., Montreal, making plans constructing hydro-electric power plant. $50,000. Pitt, Leblanc & Montpetit, c/o owner, engrs.

**Que., Montreal**—Grover Knitting Mills Ltd., 2019 Moreau St., plans constructing plant extensions. $200,000. Maturity in spring.

**Que., St. Hyacinthe**—M. A. David, city clk., interested in prices new Diesel motor for civic power plant. J. Bouchard, City Hall, engr.

**Que., Sherbrooke**—Municipality, A. Deslauriers, clk., soon takes bids constructing generator house. $134,000. W. M. Veilleaux, City Hall, engr.

**Que., Ulverton**—A. Deslauriers, city clk. of Sherbrooke, making plans constructing electric power development on St. Francis River here. $825,000. A. C. Crepeau, 45 Wellington St., Sherbrooke, archt. H. G. Acres, 7 Ferry St., Niagara Falls, Ont., engr.

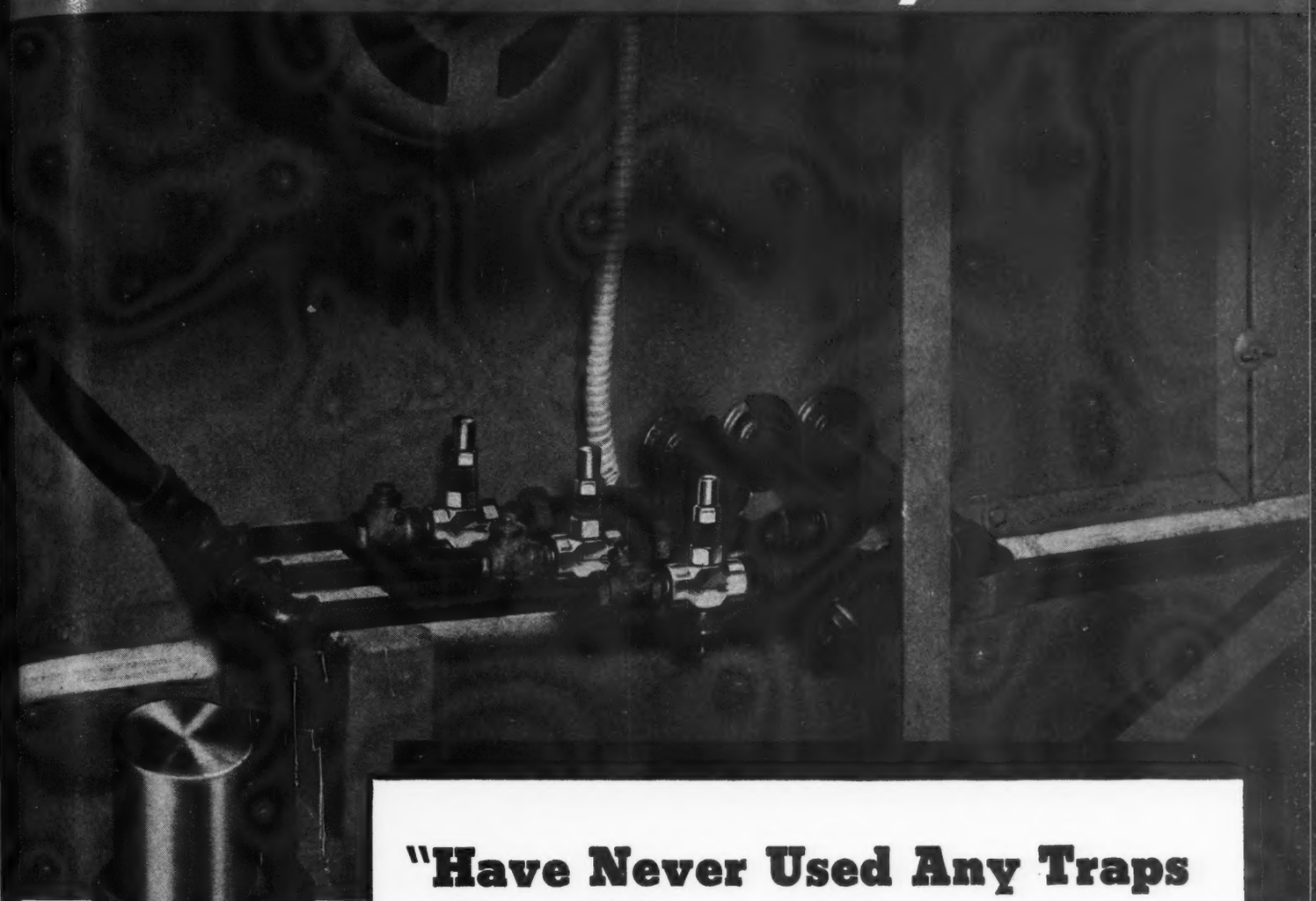
**Sask., Pelley**—Municipality making plans constructing civic electrical plant. Approved under Municipality Improvements Assistant Act. Private plans.

**Sask., Regina**—Saskatchewan Power Comn., L. A. Thornton, comr., 1739 Cornwall St., plans installing turbo-generator in local plant. $75,000.

**Sask., Regina**—City R. J. Westgate, city comr., soon takes bids improving power house. $140,000. Money will be asked under Dominion Municipal Impvt. Assistance Act.

**Sask., Saskatoon** — Saskatchewan Power Comn., c/o L. A. Thornton, 1739 Cornwall St., Regina, taking bids power plant addition and installing boiler. $250,000.

# SIX LITTLE TRAPS DOING BIG JOB 100% Efficiently



## "Have Never Used Any Traps That Were So Satisfactory"

(Frank Purcell Walnut Lumber Co., Kansas City, Kans.)

Tough trap job, draining veneer dryer. Yarway Impulse Traps reduced the heating-up period and provided greater sustained heating efficiency, saved space, simplified installation and cut maintenance costs. There are six Yarway Traps on this Proctor and Schwartz Dryer which has a capacity of 3500 feet of material per hour. Each of the six heating coils is fitted with a ½-inch Yarway Trap and Yarway Strainer (three shown above).

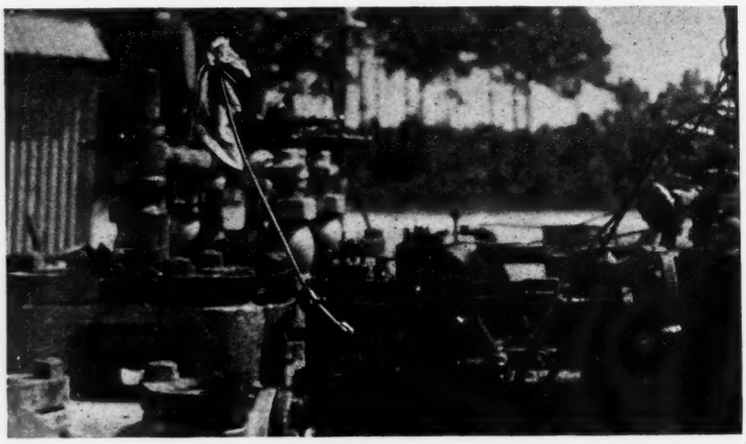
Yarway Impulse Traps are a big help in the profitable operation of steam equipment of all kinds. And when you consider that their purchase price is usually no more than the cost of repairing an old-type trap—why not get Yarway performance for your money?

A nearby Mill Supply Distributor handles them and will be glad to serve you. Or write for Catalog T-1734.

**YARNALL-WARING COMPANY**
100 Mermaid Avenue Philadelphia

# YARWAY IMPULSE STEAM TRAP

# Practical Aids to Operation



## Flag Indicates Feed-Pump Operation

IF NECESSITY is the mother of invention, then making the job easier is the father. On a steam-driven drilling rig in an oil field, the fireman wanted to know that the boiler-feed pump was running, even when he was some distance away from it. He therefore set up a flexible staff with a white cloth on its top end and connected the staff to the crank of the lubricator, as in the figure. As long as the pump is running, the cloth is in motion and gives a positive indication of operation, that can be observed from any location where the cloth can be seen.

At night a spot light is placed so that it illuminates the cloth and makes it as effective an indicator during the night as in the day time.

*Kilgore, Texas* C C LYNDE

## Adjusts Float Switch to Cut Power Costs

IN AN OFFICE building, power is purchased on a sliding rate plus a demand charge. The demand charge is $2.50 per kw based on the highest one-half-hour consumption for the month in which the charge is made. We use around 120,000 kw-hr per month with a demand of 480 kw, the demand charge alone amounting to $480 \times \$2.50 = \$1200$.

We were able to reduce the demand charge $50 per month by changing the pumping schedule of the service-water pumps. They used to run 20 min. to fill the house tank, which would be sufficient to last for 3 to 4 hr. If this 20-min operation occurred in one-half hour, it added considerable to the power-demand peak. To reduce this we shortened the float-switch rods in the tank so that the pump motors have to operate 5 min only to restore water level to normal. This amount of water lasts about one hour, consequently the motors never run more than 5 min in any one-half hour. The new schedule of operation has therefore reduced the demand peak and reduced power costs about $50 per month.

*Nutley, N. J.* THOMAS SHEEHAN

## Pipeline Condenses Blowdown Vapor

A VENT from our blowdown tank is in a valley and is about 100 ft from and 30 ft below a much used vehicular bridge. In damp, cool weather and with a slight north wind, the vapor from the blowdown tank vent drifts over the bridge and at times obscures the vision for several minutes at a time. The drain from this tank empties into a small creek, about 6 ft wide and 4 ft deep. About 100 ft downstream from the blowdown tank, a small concrete dam was built to maintain 3 ft of water in the creek at all times.

To correct the trouble from the vapor, an 8-in. line was installed from the blowdown-tank drain passing through the dam submerged. The vent was closed off as in the figure. The 100 ft of pipe now acts as a surface condenser. Some vapor comes from the discharge, but is only a small fraction of its former volume and is no longer troublesome.

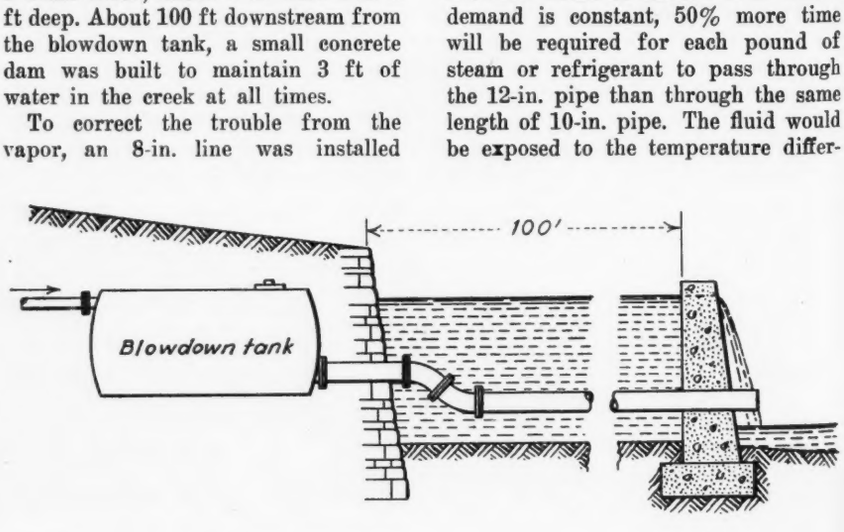
*Columbia, Mo.* R H SOGARD

## Oversize Pipe Not Always Right

WISHING to be on the safe side, many engineers and designers use oversize pipe on a job where precise data for selecting the proper size is not available. When in doubt, for instance, whether a 10- or 12-in. steam main should be installed, many engineers will choose the larger size and often will be wrong in doing so.

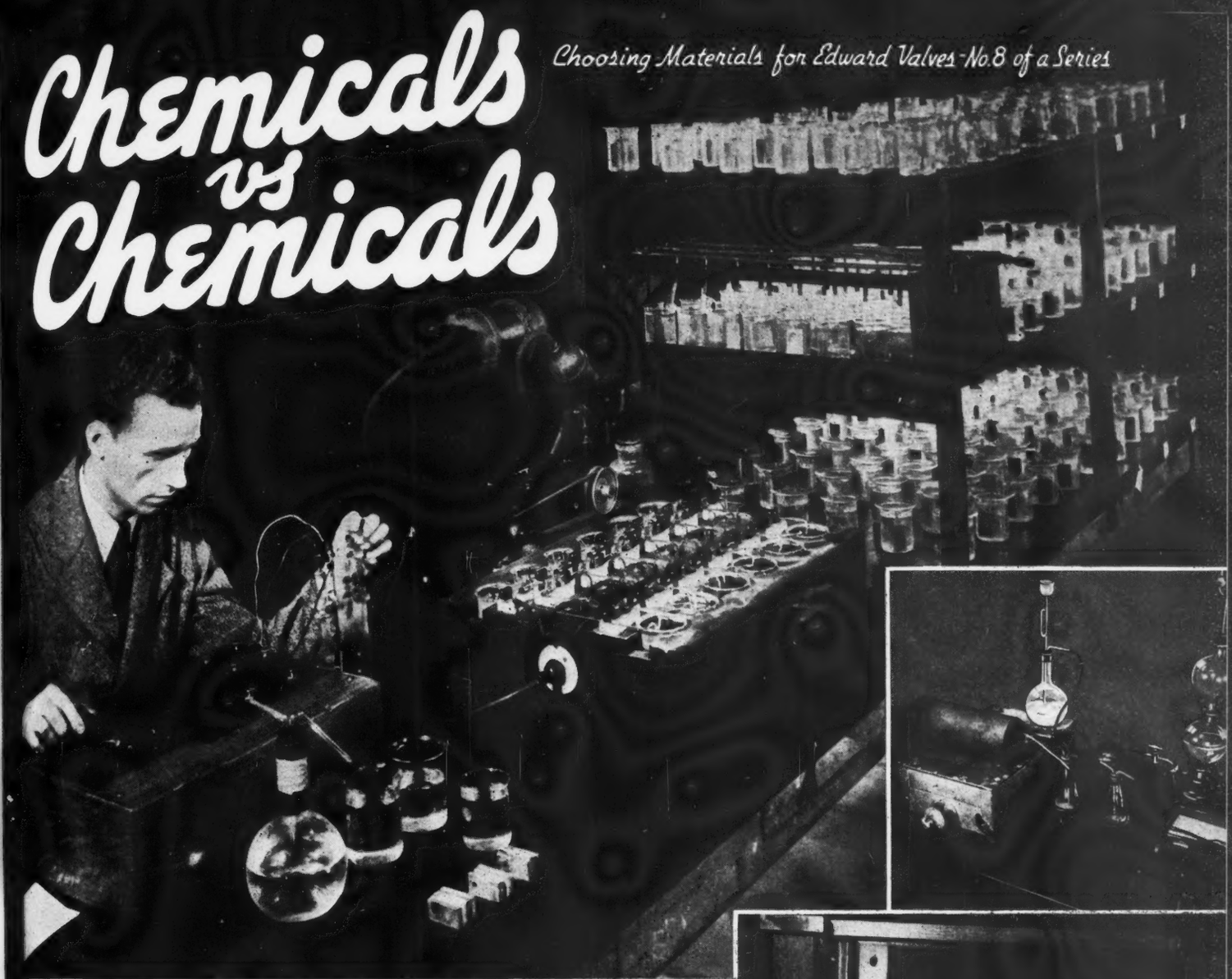
True, pressure drop in the smaller size pipe will be greater than in the larger one. If pressure drop were the major factor, as in most cold-water lines, the larger pipe should be chosen. Where the temperature inside the pipe must be maintained above or below the surrounding air, such as in steam mains and gas returns from refrigerating coils, other considerations come into the problem. Besides the extra cost of the larger pipe and heat insulation, there are losses through increased surface for radiation and by the slower rate of flow which permits more heat to escape from or be acquired by the fluid passing through the pipe.

Ratio of rates of flow in two pipes of different sizes varies approximately inversely to their cross-sectional areas. In the case of a 10-in. and a 12-in. pipe, the ratio would be about 3 to 2. Where demand is constant, 50% more time will be required for each pound of steam or refrigerant to pass through the 12-in. pipe than through the same length of 10-in. pipe. The fluid would be exposed to the temperature differ-



# Chemicals vs Chemicals

*Choosing Materials for Edward Valves-No.8 of a Series*



**IT'S the chemicals of industrial processes versus the chemistry of valve materials. An aggressive war on corrosion advances daily in Edward laboratories, seeking to enhance more fully the economic values of Edward valves. Predetermining valve life, not only from the effects of stress – temperature – erosion, but from the ravages of corrosion, is a requisite of Edward technicians — men who know that their cardinal duty, through production control and developmental research, is to give top value for your valve dollar.**

• • •

**The Edward Valve & Mfg. Co., Inc.**
EAST CHICAGO INDIANA

## CHECKING CORROSION

Valve materials, in the form of ground specimens, are immersed in corrosive fluids. Chemist (above) checks pH values of solutions with precision potentiometer. On second shelf are valve alloys in aerated solutions. Pump supplies air to each beaker.

Duplicating service conditions to find out how hydrogen sulphide behaves under temperature is the intent of hookup shown in small photograph. Correct corrosion resistant valve trim can thus be predetermined.

Right: Specimens are accurately weighed before and after subjection to corrosive media.

# EDWARD VALVES

*Stop · Check · Blow-off · Non-return · Feed Line · Relief · Bleeder Line · etc.*

ence over 20% more surface and 50% more time. Unless the larger pipes were more heavily insulated, heat loss from or heating absorption into the pipes would be greater.

If we assume that pressed-asbestos insulation, with an internal conductivity of 0.5 Btu per sq ft per degree differential is used on both pipes, a thickness of 3 in. would be needed on the 12-in. pipe to create the same overall insulating effect of 2 in. on the smaller. Weight and cost of insulation would be double, or heat loss would be twice as much.

Much has been said and written about excessive pressure drop in piping systems, but I offer the above suggestion as a warning that there is another side to the question that should not be ignored.

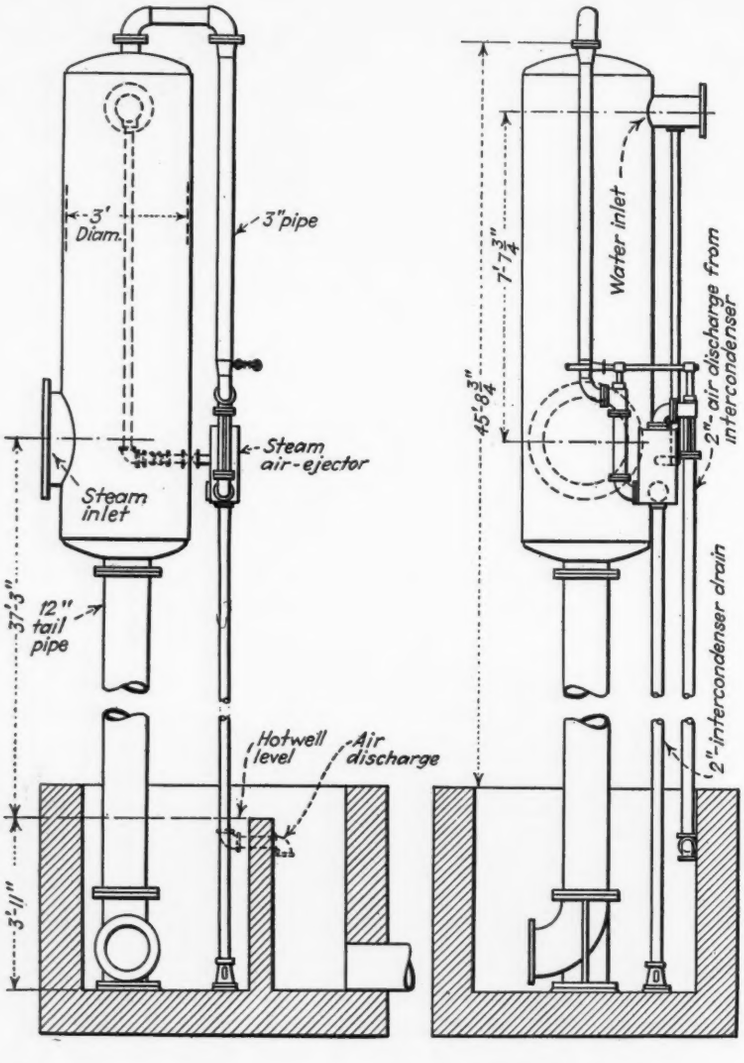
*Marissa, Ill.* GEORGE BLUM

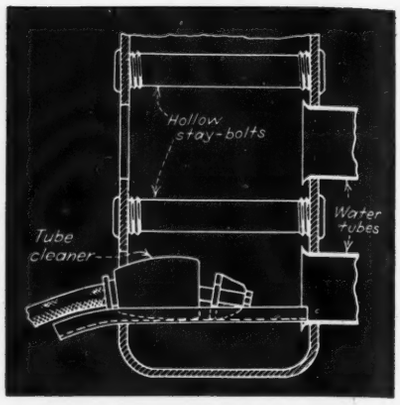
## Jet Condenser Without Cooling-Water Pump

RECENTLY we installed a 1000-kw turbine-generator with a jet condenser without a cooling-water pump. Cooling water for the condenser was to be taken from a reservoir near the plant in which water level remained practically constant at elevation 140. Water connection on the condenser head was to be placed at elevation 158, or 18 ft above the water level in the reservoir. This meant that with a vacuum of about 16 in., water would begin to flow into the condenser, leaving a reserve of 12.5 in. to insure sufficient water with a 28.5-in. vacuum. It was estimated that about 7 in. of vacuum would be needed to cause 900 gpm to flow through the pipeline, leaving 5.5 in. on the safe side.

It was therefore decided to omit the cooling-water pump and put in an oversize air ejector. The figure shows the condenser installation. Without the water pump, air has to be evacuated from the condenser before the turbine can be started. But with the oversize ejector, this is a short job. The installation has been in service for over a year with entire satisfaction and we have saved the cost of a pump, its operation and maintenance.

*Woodland, Me.* JOHN T TOPOLOSKY




## Trough Guide for Tube Cleaner

WHEN TURBINING tubes on a horizontal water-tube boiler, time may be saved by using a curved trough made of No. 20 gage iron of suitable size and length. Insert the trough through a hand hole and into the end of a tube to be cleaned, as in the figure. The turbine and cutter head may be slid through the water leg into the tube on the trough without the necessity of reaching through a hand hole to guide the cutter arms into the tube.

*Rochester, N. Y.* H P KING

## Whitewash That Really Whitwashes

WHITEWASH has a number of well known uses around the plant. Too frequently, however, its service characteristics are unsatisfactory because of the mixing method used or the lack of certain essential ingredients. Improperly compounded whitewash dusts and flakes off easily, is off color and, when exposed to weather, soon washes away. These difficulties have often influenced a change to more expensive paints, when if the whitewash has been properly made, no trouble would have occurred.

Formulas for making whitewash are more or less standardized. For interior use, the following mixture gives good results.

1. Mix approximately 80 lb of hydrated lime with water until a creamy consistency is obtained. (Use thoroughly slaked lime).

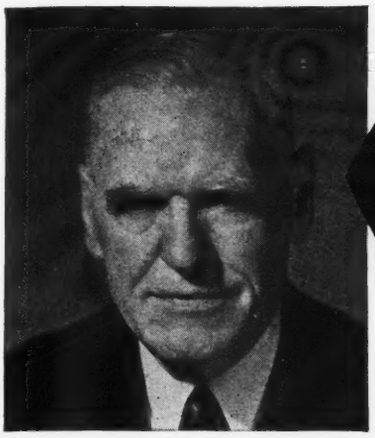
2. To 0.5 gal. of cold water add 2.5 lb of rye flour and mix thoroughly. Thin with 2 gal. of boiling water.

3. Dissolve 2.5 lb of common salt in 2.5 gal. of hot water.

4. Stir together *2* and *3* then add *1* and stir until mixed thoroughly.

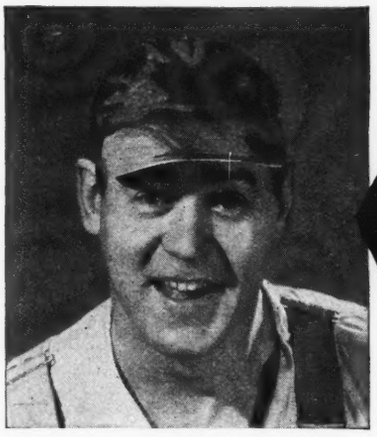
For exterior application use the following mixture:

1. Mix approximately 80 lb of hy-



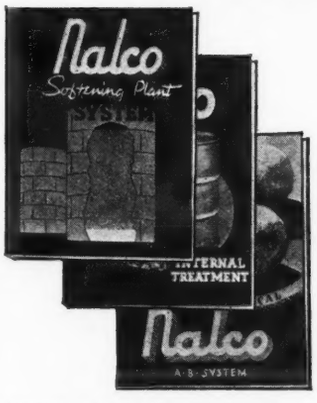
I use Nalco Internal Treatment

I use the Nalco Service for Softening Plants



I use the Nalco AB System

# And all agree that Nalco does the job!




COPIES of the above bulletins will be mailed to any interested reader without obligation. Simply specify the one desired. Write.

**NALCO service is designed to fit the needs of the individual plant. Your neighbor may be using the Nalco System in conjunction with an existing softening plant; whereas, in your case, study of facts might indicate use of Nalco Internal Treatment or Nalco AB Treatment. Thus, you get the benefit of unbiased judgment—Nalco has no equipment to sell you—Nalco engineers make use of latest proven chemicals—they have no pet panacea to recommend as a "cure-all" for every trouble. This explains why Nalco can give complete satisfaction in such a wide variety of plants. NATIONAL ALUMINATE CORPORATION, 6222 W. 66th Place, Chicago, Illinois.**

ANY WATER **NALCO SYSTEM**

Inquiries other than domestic *except those from U. S. Possessions, Canada and Mexico,* should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

drated lime with water until a creamy consistency is obtained.

2. Dissolve 2 lb of common salt and 1 lb of zinc sulphate in 2 gal. of boiling water.

Mix *2* and *1* and then add 2 gal. of skim milk.

There are a number of other ingredients which will improve the qualities of whitewashes. A pint of molasses added to 5 gal. of whitewash improves its penetrating value when applied to wood and plaster. Alum toughens the film and prevents rubbing off. One pound of cheap bar soap dissolved in 1 gal. of boiling water, mixed with 5 gal. of whitewash, will give a glossy finish to the completed job.

If you generate your own acetylene gas for welding or other purposes, the residue from the generators can be substituted for commercial hydrated lime. Should the residue be available and of a clay-like consistency, substitute about 120 lb for the 80 lb of hydrated lime specified in the foregoing formulas. This allows for the water in the residue.

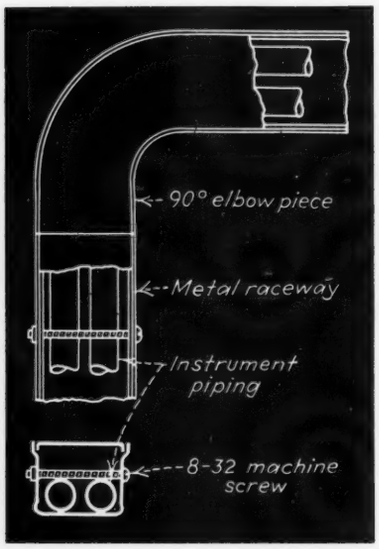
*Roanoke, Va.* S H Coleman

## Electrical Metal Raceway Protects Meter Tubing

Tubing used for combustion-control and automatic process-control lines or similar connections, designated generally as instrument piping, can be protected and appearance of the installation improved by installing the lines in some form of protective casing. Conventional electrical metal raceways with snap-on cover plates, as shown in figure, serve the purpose very nicely.

These can be procured in various widths and depths to accommodate 2 or more tubes, and in 10-ft lengths with suitable couplings, crosses, elbows, and similar fittings. This material is strong and relatively light and can be secured in place with brackets, hangers, or by tack welding to steel columns, trusses, beams, and other structural members. They can be adapted equally well to copper tubing with soldered fittings, copper tubing with compression fittings, and to capillary tubing.

When making the installation, the channel sections are first connected together and secured in place for the entire run, care being taken to keep the straight portions true to line and grade. The tubing is then put into place and connected to the meters, controllers and instruments in the system. For vertical runs, the tubing is held in the raceway by machine screws bolted through the channel section at intervals of approximately 4 ft. On




horizontal runs with the covers on top, the screws may be omitted for the snap-on cover plate will prevent the tubing from coming out of the raceway.

*Vallejo, Calif.* Theron W Bean

## Bunker-Spout Changes Eliminate Coal Fires

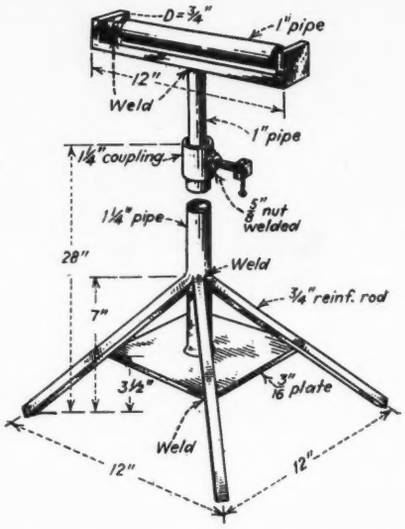
The diagram shows a pulverized-fuel bunker and weigh-scale layout, as installed in one plant. At *P* on each spout, a sliding gate serves to cut off the coal supply when repairs or adjustments are made on the scale. It was found that the coal from the bunker tended to run mostly from the center spout over each scale, whereas the end spouts supply very little, even when the bunker was half filled. Consequently, coal near the end spouts remained in the bunker, started to smoulder, causing trouble and expense of putting out fires and removing the clinker and loss of coal.

To overcome this difficulty, the spouts were reconstructed and a sliding gate installed in each one near the bunker. This permitted controlling coal flow in each spout to eliminate dead zone and fires in the bunker. Since installing this system, we have had no trouble with fires in the bunker.

*Passaic, N. J.* Gordon Bell.

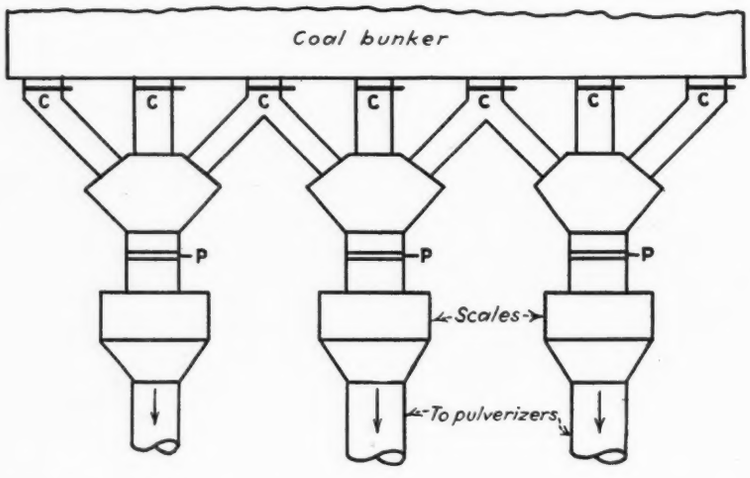
## Roller Pipe Support Made by Welding

When installing some new equipment in a local plant, a pipe roller support was required by the pipe fitters. One of the welders built one like that shown in the figure, from material available around the plant. This support proved to be entirely satisfactory and after the rush work was completed, it replaced the older

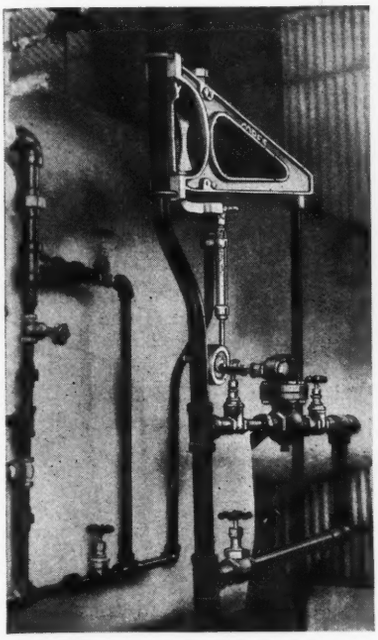



roller pipe support in the plant, which was made of cast iron. The pipe fitters find the welded support much lighter and convenient than the older cast one, which cost several times as much as the new one.

*Hibbings, Minn.* A L Bennett



## COPES FOR SMALL BOILERS



If you operate small boilers at moderate ratings and pressures, investigate the COPES Type OT Feed Water Regulator.

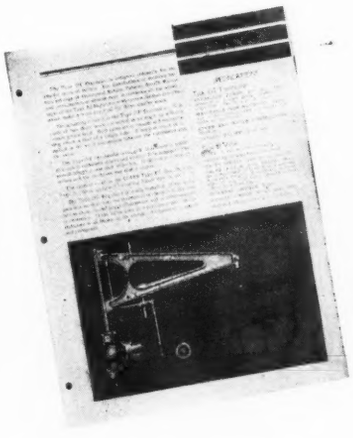
Feeds continuously to a working boiler, as needed for the level and furnace conditions. Gives more steam per pound of fuel; pays for itself quickly.

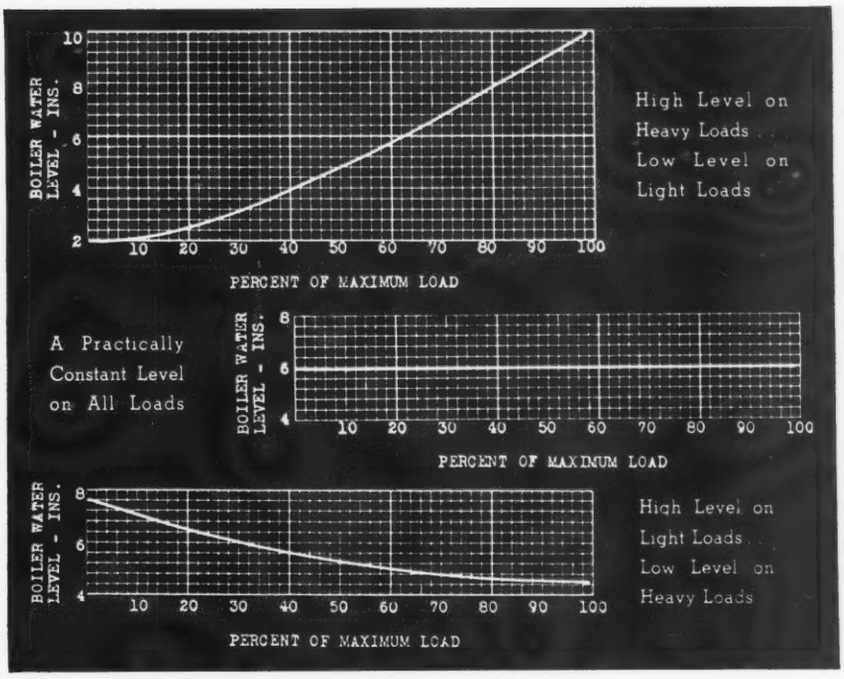
Stabilizes boiler water level, preventing damage from exposed tubes or water carry-over to prime movers or process. Your boiler operation is safer.

Fully-automatic and needing no more attention than a water column, it releases operators for more important duties than watching the water level.

Easily installed on any small boiler. For complete data—

Write for Bulletin P-2A






# Water Level—as You Want It

Your operating conditions differ from those in any other plant. Your boiler feed control must therefore give you exactly the water level control you know to be best for your boilers. That's the purpose of the COPES Flowmatic Regulator. It gives you the water level characteristic—rising, lowering or practically-constant—that makes your boiler operation safest and most economical. Write for descriptive Bulletin 409-B—your letterhead, please.

NORTHERN EQUIPMENT CO., 211 GROVE DRIVE, ERIE, PENNA.

*Feed Water Regulators, Pump Governors, Differential Valves*
*Liquid Level Controls, Reducing Valves and Desuperheaters*

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA AND ITALY . . . . REPRESENTATIVES EVERYWHERE

*Get closer level control with the*

COPES

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

FLOWMATIC

★ REGULATOR

# Current Comment

## Disagrees on Galvanizing

WE HAVE BEEN very much disturbed by the letter "Why Galvanize Inside of Iron Pipe" (E J Davis, page 97, November, 1938, *Power*.) There is no foundation, so far as we can ascertain, for certain of the statements, and others are contrary to known facts.

It is true that in many types of water the rate at which zinc coatings are dissolved is rapid enough to make it questionable whether the slight increase in life would, insofar as attack from the inside is concerned, pay for galvanizing. It is probable, however, that the saving which could be effected by galvanizing only the outside of pipe for such localities would be very small, and that in the average case the small additional cost of galvanizing the inside, as well as the outside, would be repaid.

The facts concerning the subject matter of the second paragraph are that chlorine added to the average water converts to hypochlorous and hydrochloric acids, the latter present in very small quantities. Evidence is available to indicate that in certain waters of reasonable hardness, further reactions take place in which the chlorine is converted to a fixed nonreactive chloride. It is probable that few instances can be found where this does not occur.

Mr Davis says that galvanizing the inside of pipe tends to precipitate iron and calcium, increasing the rate of blockage and actually increasing the rate of corrosion. There is no basis in chemistry or in actual experience for this. Under no type of exposure have we ever encountered a case where the presence of zinc increased the rate of corrosion of iron. In fact, in every case there has been at least some protective action. We do not believe that there is any basis for the thesis that deposits of rust or lime are either more likely to precipitate or more likely to adhere to a zinc surface than to an iron surface.

*New York, N. Y.* ERNEST V GENT
*American Zinc Institute, Inc.*

## About Small Stokers

YOUR RECENT articles on stokers have been very interesting, but I suggest that you pay some attention to the geographic location of the stoker to be installed with relation to the kind of coal available in that place.

For instance, the type of stokers produced in the Middle West are not, as a general rule, very adaptable to the heavy caking bituminous coal available in Northwestern U. S. By this, I mean that these stokers are originally designed and tested to burn the kind of coal available near point of manufacture.

Also, I believe you could well afford to pay some attention to the type of stoker designed to burn anthracite coal, which is again a question of geographic location.

*Syracuse, N. Y.* E W ZIMMERMAN

## Diesel Thermal Efficiency

CERTAIN ENGINEERING practices are sometimes followed erroneously, because of past customs formed during early stages of development.

One of these seems to be the use of the higher heating value of fuel oil. This higher value is the one most easily obtained from bomb calorimeter tests, but the engine should not be charged with this heat value in computing test results or thermal efficiency. The latent heat of vaporization of the water vapor formed during combustion is not used in the engine, but can be used in waste-heat processes or boilers.

For example: The thermal efficiencies by the two heat values using fuel consumption at 0.4 lb per brake hphr are:

Higher Heat Value=2545 Btu=33.5%
Thermal Efficiency $\frac{19{,}000 \times 0.4}{}$

Lower Heat Value=2545 Btu=35.3%
Thermal Efficiency $\frac{18{,}000 \times 0.4}{}$

*Baltimore, Md.* B W DENNIS
*Maryland Diesel Schools, Inc.*

## Who's an Engineer?

REFERRING to the question asked by John Doe of XYZ plant on page 96 of November POWER, I beg to set down my opinion. My understanding is that engineers are of two classes. Designing and construction engineers—those who put to practical use that which is discovered or developed by scientific research. The second class is those who control and operate appliances and mechanisms after they are constructed.

To the latter class, known as operating engineers, belong the great army of men, including John Doe, and the writer, who operate, handle, control and maintain our power plants, etc. Both classes are equally necessary to the engineering world. One cannot do without the other.

If John Doe has studied and understands the class of equipment he has charge of, can visualize what goes on inside hidden parts, can handle and maintain it, and can operate it economically and to its highest efficiency, he is just as truly an engineer as though he had a diploma and a license.

He should continue to improve and increase his knowledge to keep pace with improvements and changes as they come along, and walk about his plant with head up and chest forward. He is an engineer worthy of respect—an operating engineer!

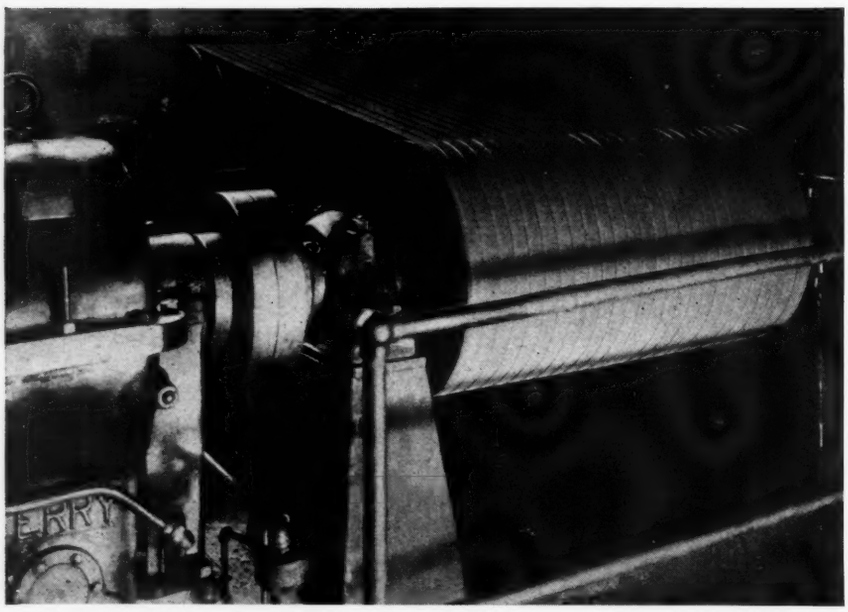
*Seattle, Wash.* JBP

## A Problem for Industry

I FEEL that American industry should consider the evils of reciprocal buying. This exploded theory is continued only because of its age, not because anyone in industry finds it a satisfactory method of placing business.

At great expense, industry sets up a purchasing department, an inspection department and an engineering department to produce material of proper price

(*Continued on page* 126)



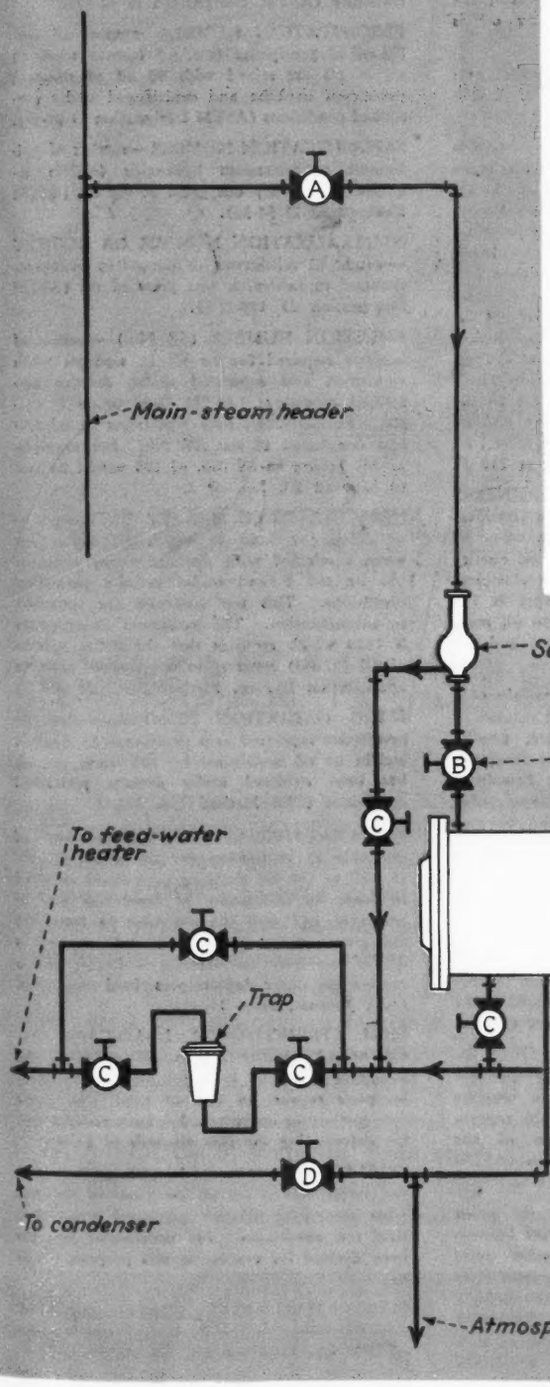

MATCHED DRIVE

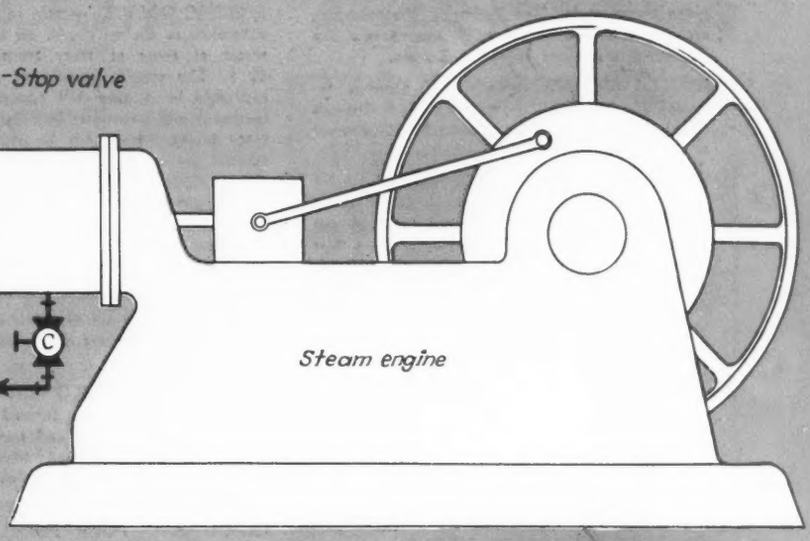
Matched set of 26 Goodrich V-belts on a 550-hp Terry steam-turbine drive at large southern paper plant. Interesting is the fact that, after 12 months operation, all belts are running in practically the same plane, denoting that the 26 belts have worn equally and are exerting about equal tension.

# . . . TO *GOOD* VALVE PRACTICE

# *Jenkins* RECOMMENDS . . .

## STEAM, DRAINS AND EXHAUST




## REFERENCE CHART FOR JENKINS FIGURE NUMBERS

| | | 100 lbs. S.P. | Up to 200 lbs. S.P. | Up to 300 lbs. S.P. | Up to 400 lbs. S.P. | Up to 600 lbs. S.P. |
|---|---|---|---|---|---|---|
| A | STEAM LINES GLOBE..... | IRON<br>142 Fl. Disc Type<br>913 Fl. Regrinding | IRON<br>162 Fl. Disc Type<br>923 Fl. Regrinding<br>STEEL<br>1042 Fl. 30-Series | STEEL<br>1042 Fl. 30-Series | STEEL<br>1044 Fl. 40-Series | STEEL<br>1046 Fl. 60-Series |
| | GATE..... | IRON<br>651 Fl. O.S. & Y. | IRON<br>204 Fl. O.S. & Y.<br>STEEL<br>1010 Fl. 30-Series | STEEL<br>1010 Fl. 30-Series | STEEL<br>1011 Fl. 40-Series | STEEL<br>1012 Fl. 60-Series |
| B | STOP VALVES GLOBE..... | IRON<br>913 Fl. Regrinding | IRON<br>923 Fl. Regrinding<br>STEEL<br>1042 Fl. 30-Series | STEEL<br>1042 Fl. Regrinding 30-Series | STEEL<br>1044 Fl. 40-Series | STEEL<br>1046 Fl. 60-Series |
| | ANGLE..... | IRON<br>915 Fl. Regrinding | IRON<br>925 Fl. Regrinding<br>STEEL<br>1043 Fl. 30-Series | STEEL<br>1043 Fl. 30-Series | STEEL<br>1045 Fl. 40-Series | STEEL<br>1047 Fl. 60-Series |
| C | DRAINS GLOBE..... | BRONZE<br>106A Sc. Disc Type<br>750 Sc. Regrinding<br>950 Sc. Regr.-Ren.<br>IRON<br>141 Sc. Disc Type<br>142 Fl. Disc Type<br>912 Sc. Regrinding<br>913 Fl. Regrinding | BRONZE<br>1140 Sc. Regrinding<br>1150 Sc. Regr.-Ren.<br>IRON<br>162A Sc. Disc Type<br>162 Fl. Disc Type<br>922 Sc. Regrinding<br>923 Fl. Regrinding<br>STEEL<br>1042 Fl. 30-Series | BRONZE<br>970 Sc. Regr.-Ren.<br>976 Sc. Regr.-Ren. Plug Type<br>STEEL<br>1042 Fl. 30-Series | STEEL<br>1044 Fl. 40-Series | STEEL<br>1046 Fl. 60-Series |
| | ANGLE..... | BRONZE<br>108A Sc. Disc Type<br>752 Sc. Regrinding<br>952 Sc. Regr.-Ren.<br>IRON<br>143 Sc. Disc Type<br>144 Fl. Disc Type<br>914 Sc. Regrinding<br>915 Fl. Regrinding | BRONZE<br>1141 Sc. Regrinding<br>1152 Sc. Regr.-Ren.<br>IRON<br>163A Sc. Disc Type<br>163 Fl. Disc Type<br>924 Sc. Regrinding<br>925 Fl. Regrinding<br>STEEL<br>1043 Fl. 30-Series | BRONZE<br>972 Sc. Regr.-Ren.<br>978 Sc. Regr.-Ren. Plug Type<br>STEEL<br>1043 Fl. 30-Series | STEEL<br>1045 Fl. 40-Series | STEEL<br>1047 Fl. 60-Series |
| D | EXHAUST LINE GATE..... | BRONZE<br>370 Sc. Non-Rising<br>368 Sc. O.S. & Y.<br>47 Sc. Travel. Stem<br>49 Sc. Travel. Stem<br>670 Sc. Non-Rising<br>IRON<br>650 Sc. O.S. & Y.<br>651 Fl. O.S. & Y.<br>325 Sc. Non-Rising<br>326 Fl. Non-Rising | | | | |

Motor operated Iron and Steel Valves can be supplied. Cast Steel Valves with ends for welding can be supplied.

**#2 OF A SERIES** designed to help in your selection of JENKINS VALVES

**JENKINS BROS., 80 WHITE STREET, NEW YORK, N. Y.**

Bridgeport • Boston • Chicago — Philadelphia • Atlanta • Houston

1864—1939 DIAMOND ANNIVERSARY

Number 78

# Dictionary of Lubrication—I

## Lubricating-Oil Properties

VISCOSITY—measure of resistance to flow. Viscosity may be regarded as a measure of internal fluid friction. There is no standard unit for measuring viscosity.

SAYBOLT UNIVERSAL SECONDS (SUS or SSU)—number of seconds required for 60 milliliters of an oil to flow through the orifice of the Standard Saybolt Universal Viscosimeter at a given temperature. Standard temperatures are 70, 100, 130 or 210 F.

SAYBOLT FUROL SECONDS (SS FUROL)—number of seconds required for 60 milliliters of an oil to flow through the orifice of the Standard Saybolt Furol Viscosimeter at a given temperature. Standard temperatures are 77, 100, 122 or 210 F. The Saybolt Universal Viscosimeter is used for oils having times of flow of more than 32 sec and generally less than 100 sec. The Saybolt Furol Viscosimeter is used for oils having times of flow of more than 25 sec. The outflow time of the Universal Viscosimeter is approximately 10 times that of the Furol instrument for SSU values from 300 to 5000 sec. For values between 300 and 100 sec SSU, the ratio varies from approximately 10 to 6½ at 100 SSU. The word "Furol" is a contraction of "fuel and road oils" and is principally used for those oils. These are the standard commercial instruments for measuring viscosities in the U. S.

REDWOOD STANDARD SECONDS—number of seconds required for 50 milliliters of oil to flow through the Redwood Standard Viscosimeter (No. 1 instrument) at given temperature.

REDWOOD ADMIRALTY SECONDS—number of seconds required for 50 milliliters of oil to flow through the orifice of the Redwood Admiralty Viscosimeter (No. 2 instrument) at a given temperature. The Redwood Viscosimeters are the standard commercial instruments for measuring viscosities in Great Britain.

ENGLER SECONDS—number of seconds required for 200 milliliters of oil to flow through the orifice of the Engler Standard Viscosimeter at a given temperature.

ENGLER DEGREES—(sometimes called Engler Number and Specific Viscosity)—Engler Seconds divided by the time in seconds required for 200 milliliters of distilled water at 20 C to flow through the orifice of the Engler instrument, which time varies between 50 and 52 sec for different instruments. The Engler viscosimeter is used practically universally in Continental Europe and is the standard in Germany.

POISE—a term for "absolute viscosity", signifies 1 dyne seconds per square centimeter. The absolute viscosity is usually referred to as dynes per sq cm.

VISCOSITY UNITS—One Poise or one dyne sec per sq cm =

$1.02 \times 10^{-2}$ kilogram sec per sq meter
$2.09 \times 10^{-6}$ pound sec per sq ft
$1.45 \times 10^{-5}$ pound sec per sq in
$2.45 \times 10^{-7}$ pound min per sq in

In order to avoid decimals, the centipoise is used, being one-hundredth of the poise. Another term is kinematic viscosity, obtained by dividing the absolute viscosity by the density of the oil. The absolute metric units of kinematic viscosity are called stoke and centistoke and correspond to poise and centipoise.

RELATIVE VISCOSITY—viscosity of a liquid in terms of the viscosity of some other liquid arbitrarily chosen as a standard. The viscosity of distilled water at 20 C is most frequently used as standard. For example, the absolute viscosity of distilled water at 20 C is 1.005 centipoises and that of castor oil is 986 centipoises; the relative viscosity, therefore, of castor oil is $986 \div 1.005 = 981$

SPECIFIC VISCOSITY—relative viscosity, particularly where the viscosity of water at 20 C is the standard.

VISCOSITY INDEX (VI)—relationship between viscosity changes of various oils with given changes in temperature. The perfect oil, as far as viscosity is concerned, would be one having a constant viscosity regardless of temperature. No such oil exists—all thin out (have lower viscosity) at high temperature and thicken (increase in viscosity) at low temperatures. Changes in viscosity with temperature change are not the same for all oils; some thin out more or thicken less than others for a given temperature change. Specifically, the VI indicates the relation which the viscosity of an oil at 100 F bears to the viscosities of an average Pennsylvania and an average Coastal oil at that temperature, all three oils having the same viscosity at 210 F.

SOCIETY OF AUTOMOTIVE ENGINEERS VISCOSITY NUMBER (SAE No.)—a classification of crankcase lubricating oils in terms of SSU viscosity only. Other factors of oil quality or character are not considered. This classification is based on SSU viscosity ranges at 130 and 210 F. For example, an SAE 30 oil must have a viscosity of not less than 185 and not more than 255 SSU at 130 F.

SPECIFIC GRAVITY—ratio of the weight of a substance to the weight of an equal volume of water at some arbitrary temperature, usually 60 F. The specific gravity of oil is frequenly expressed in degrees API (American Petroleum Institute) and sometimes in degrees Baumé, arbitrary scales which can be converted to true specific gravity by the following formulas:

$$\text{Specific gravity} = \frac{141.5}{131.5 + \text{deg API}}$$

$$\text{Specific gravity} = \frac{140}{130 + \text{deg Baumé}}$$

It is not, however, necessary to weigh oil because hydrometers are available calibrated to the API scale, the Baumé scale, and true specific-gravity scale.

CARBON RESIDUE (CONRADSON)—percentage of carbon residue formed in a crucible when oil is vaporized and burned in accordance with a prescribed procedure of the American Society for Testing Materials (ASTM Designation D 189-36).

CLOUD AND POUR POINTS—cloud point of an oil is the temperature in degrees Fahrenheit at which paraffin wax or other solid substances begin to crystallize or separate from solution when the oil is chilled under definite prescribed conditions. Pour point is the lowest temperature at which an oil will pour or flow when it is chilled under definite prescribed conditions (ASTM Designation D 97-34).

FLASH AND FIRE POINTS (CLEVELAND OPEN CUP)—flash point of an oil is the temperature at which sufficient vapor is given off to form momentarily an inflammable mixture with air when a small flame is applied. Fire point is the temperature in degrees at which this inflammable mixture will burn continuously (ASTM Designation D 92-33).

PRECIPITATION NUMBER—number of milliliters of precipitate (sludge) formed when 10 ml of oil are mixed with 90 ml of standard petroleum naphtha and centrifuged under prescribed conditions (ASTM Designation D 91-35).

SAPONIFICATION NUMBER—number of milligrams of potassium hydroxide (KOH) required to saponify one gram of the oil (ASTM Designation D 94-36).

NEUTRALIZATION NUMBER OR ACIDITY—weight in milligrams of potassium hydroxide required to neutralize one gram of oil (ASTM Designation D 188-27T).

EMULSION NUMBER (SE No.)—number of seconds required for an oil to separate when emulsified and separated under definite prescribed conditions (ASTM Designation D 157-36). Formerly this time was taken in minutes and designated as the RE No. For example, an oil having an SE No. of 120 would be said to have an RE No. of 2.

HERSCHEL DEMULSIBILITY TEST—rate in milliliters per hour at which oil settles out when emulsified with distilled water either at 130 or 180 F and under definite prescribed conditions. This test indicates the resistance to emulsification. The maximum demulsibility is 1620 which requires that the entire volume of oil (27 ml) separate in one minute (Federal Specification Bureau, Method No. 320.32).

SLIGH OXIDATION NUMBER—weight of precipitate expressed as a percentage of original weight of oil multiplied by 100 when the oil has been oxidized under definite prescribed conditions (FSB Method No. 340.1).

INDIANA OXIDATION TEST—amount of insoluble in milligrams per 10 grams of oil, as well as (a) the sludging time (time required to form 10 milligrams of insolubles per 10 grams of oil) and (b) the time to form 100 milligrams of insolubles. The solvent used is ASTM precipitation naphtha and the test is carried out under definite prescribed conditions. (SAE Journal, May, 1934).

FILM STRENGTH OR LOAD-CARRYING CAPACITY—ability of an oil to resist the squeezing action of high unit pressures without complete rupture of the oil film. No single test, method or instrument has been standardized for determining the film strength of an oil.

OILINESS—difference in friction greater than can be accounted for on the basis of viscosity when comparing different lubricants under identical test conditions. No satisfactory test has been devised for evaluating this property of an oil.

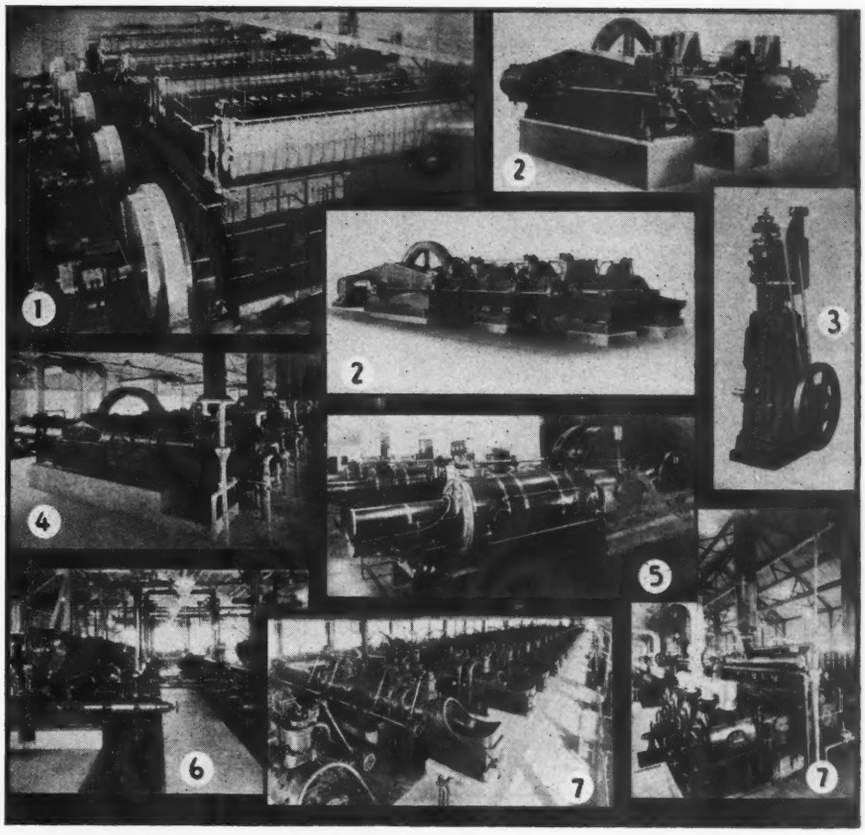
LUBRICATING VALUE—frequently used in oil advertisements. It has no specific meaning and no test has been devised for determining it. The U. S. Navy Work Factor Test comes as close, perhaps, to evaluating this property of an oil as any known test.

 *(This dictionary will be continued in March POWER)*

© POWER

## 50 YEARS MANUFACTURING EXCLUSIVELY METAL PACKINGS FOR PISTONS AND RODS

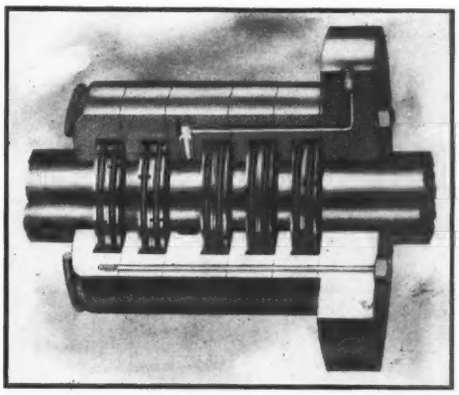
*The units illustrated are typical of the many engines and compressors that are delivered factory equipped with COOK'S Metallic Rod Packings: (1) Hooven, Owens, Rentschler Double-Acting Diesels, (2) Cooper-Bessemer Gas Engines and Compressors, (3) Wachs Steam Engines, (4) Clark Gas Engines and Compressors, (5) Skinner Steam Engines, (6) Ingersoll-Rand Gas Compressors, (7) Worthington Gas Engines and Compressors.*




# SAVE POWER-CUT UP-KEEP COSTS
## *with*
# COOK'S METALLIC PACKINGS

ANY engine or compressor is a more efficient unit if its rods are equipped with COOK'S Metallic Packings. Featuring the sound basic principle of ***floating*** rings in combination with exclusive materials and designs, COOK'S Metallic Packings offer both builders and operators a product of ***unequalled sealing properties and long life.*** They reduce friction to a mere fraction—keep rods like new—defer maintenance for years. They have been the choice of leading builders and progressive operators of reciprocating machines for over 50 years. Many modern engines and compressors are delivered factory equipped with COOK'S Metallic Packings—others furnish them on request.

When ordering new equipment, make sure you get the genuine by ***specifying "COOK'S Metallic Packings" by name.*** When considering packings for equipment in service, write for informative literature, either direct to us or through the equipment manufacturer.



*Shown above is COOK'S Annular Cup Type Packing—one of a complete line that satisfies all engine and compressor service conditions. In all types the packing rings FLOAT in cases fashioned to fit into existing stuffing boxes. This "floating" principle prevents loss of sealing efficiency or increased wear should rod deflection or misalignment occur.*

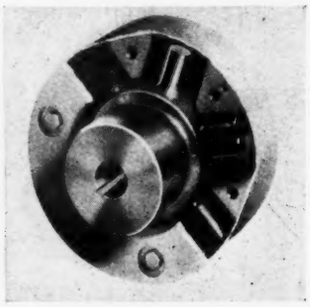
**C. LEE COOK MANUFACTURING CO.**
INCORPORATED
New York Cleveland Los Angeles Baltimore **LOUISVILLE, KY.** Chicago Tulsa New Orleans San Francisco

SEALING PRESSURES SINCE 1888

# What's New in Plant Equipment

## Flexible Coupling

"MORFLEX" couplings use specially shaped rubber trunnion bushings to provide effective flexing medium for withstanding shock loads and absorbing vibration. In radial type, bushings are assembled radially, equally spaced on steel pins of yoke member. 2-piece metal housing encases rubber bushings, and



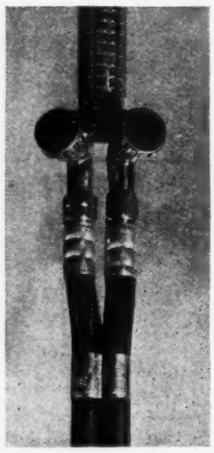
provides for bolting companion flange. As there is no metal to metal contact between halves of coupling, it is insulated against noise and electricity. Capacities range from 2 to 37 hp at 100 rpm.

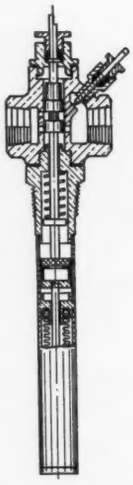
*Morse Chain Co, Ithaca, N. Y.*

## Field-Frequency Relay

IN STARTING a synchronous motor, there is a most favorable period for applying excitation current to the field coils. Polarized field-frequency relay, illustrated, has been developed to close automatically field circuit at the correct time. It is continuously conscious of the alternating north and south polarity of induced current in motor-field winding during starting period. Therefore, relay always operates in the half cycle of induced-field-current wave that is of correct polarity for applying field excitation. This insures that motor will develop maximum pull-in torque to bring its load into synchronization in minimum time and with least possible voltage disturbance resulting from current surges during starting.

*Electric Machinery Mfg Co, Minneapolis, Minn.*





## Welding Hose

"TWINWELD" hose, for conveying oxygen and acetylene for welding and cutting work, consist of two lines of flexible, cord-reinforced welding hose molded into a single unit. Will not kink, writhe or twist under pressure. Hose is installed by splitting it with a knife along joint line at each end to form a Y at both tank and torch ends. Ferrules are then crimped to prevent any further separation. Available in any desired cut length or in continuous lengths as long as 500 ft.

*Hewitt Rubber Corp, Buffalo, N. Y.*

## Cooling-Water Control *(above)*

TYPE TR-40 cooling-water control, designed expressly for cooling-water jackets of internal-combustion engines and compressors, consists of a piston valve operated by a liquid-expansion thermostat to throttle flow of controlling water as required to maintain constant temperature. Valve has a bleeder port adjustable from outside, which allows a small amount of cooling water to flow at all times. This also keeps thermostat active and ready to respond. Innovation is a safety device, a fusible plug inserted between thermostat plunger and valve spindle in such a way that in event of thermostat failure, plug will collapse and water valve will be forced wide open. Sizes $\frac{3}{8}$ to 1 in.

*Sarco Co, Inc, 183 Madison Ave, New York, N. Y.*

## Diesel Silencer

"VORTEX SYNCRO-SILENCER" is designed to synchronize correct silencing properties with all noise conditions, from initial explosion in combustion chamber to atmospheric discharge from tail pipe. Is similar to other commercial types in size and external physical appearance. Manufacturer describes action of this muffler as a "stepping-down" process that can be likened to replacing a sharply vertical waterfall with a series of gentle slopes. Exhaust-gas impulses and sound waves are stepped down to discharge quietly without appreciable backpressure, change of direction or power-consuming obstructions. Made for all types of diesels from 75 hp up.

*Engineer Specialties Co, Inc, 39 Cortland St, New York, N. Y.*

## Furnace-Pressure Controller

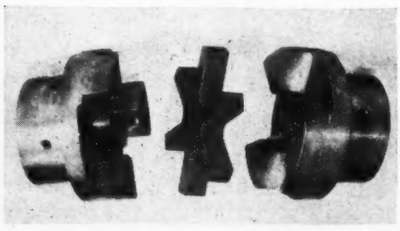
"AIR-O-LINE" furnace-pressure controller, for all types of furnaces, stills, etc, where low differential or static pressure must be maintained, controls any pressure from —5.0 in to +5.0 in. $H_2O$. Is essentially a sensitive, inverted-bell draft in-

dicator combined with Brown Air-o-Line control unit. Automatic reset and adjustable throttling range prevent furnace pressure from lining out at some point other than control point and eliminate over-correcting and cycling.

*The Brown Instrument Co, Philadelphia, Pa.*

## Flexible Coupling

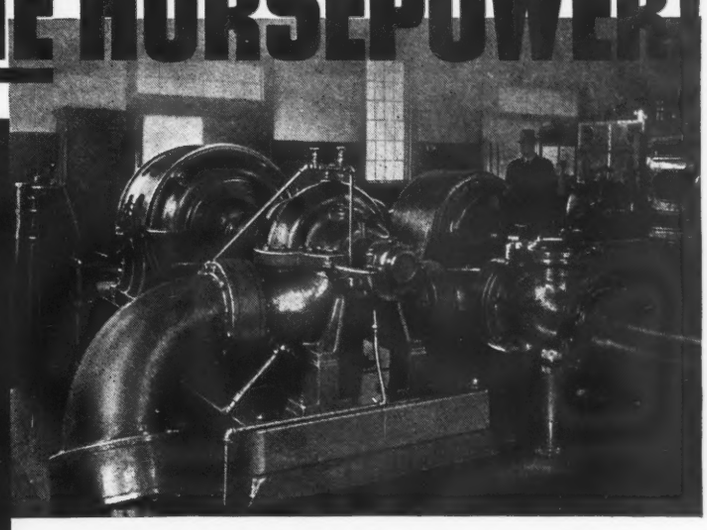
"BONDTRU" flexible coupling has been improved to give larger horsepower ratings and larger maximum bores. In the Bondtru, two metal flanges having projecting segments engage each other



through a non-metallic insert, arms of which carry load in compression. Power-transmitting capacity is governed by outside diameter of coupling and total load-bearing surface of insert. Five intermediate sizes of the coupling have been redesigned to employ inserts with

# 1,000,000 MORE GALLONS PER DAY WITH THE SAME HORSEPOWER!

**Read the Sensational Story of How Pueblo, Colorado, Jumped Up Its Delivery of Water a Million Gallons a Day . . . At No Extra Cost for Power! Find Out How You Can Make Similar Savings . . . by Modernizing with Allis-Chalmers Pumps!**



THIS NEW Allis-Chalmers Centrifugal Pump uses no more horsepower than the 20-year old pump it replaced . . . and yet it delivers a million gallons of water more per day! A. H. Wagner, Water Works Superintendent of Pueblo (standing back of the pump), tells this remarkable modernization story.

Here are facts that tell you their own story . . . facts that should make you ask yourself if YOU are getting modern efficiencies and lowest costs from your pumps!

Twenty years ago, in Pueblo, Colorado, a pump was installed . . . at that time the most advanced, most efficient pumping equipment on the market. Since then, this pump has done its job well, delivering water from the Arkansas river to the city of Pueblo at a reasonable cost. But to A. H. Wagner, Public Water Works Superintendent, this was not enough. He believed that modern equipment would give better results. In the fall of 1938, he replaced the 20-year old unit with a new, up-to-date Allis-Chalmers Centrifugal pump . . .

And when they hooked up that new pump and examined their meters . . . here's what they found! They found they were delivering a million gallons of water more . . . every day . . . with the same horsepower . . . at no extra cost!

Dollar-saving performances like these are the best kind of figures you can show your city or plant! If you are now using old pumping equipment, it will pay you to learn the modernization story of Allis-Chalmers equipment . . . and how you can show savings like these!

## More Water at Less Cost!

For over fifty years Allis-Chalmers has been making pumps with the two-fold engineering aim of providing equipment that will deliver more water at less cost! In municipalities and industrial plants all over the world, Allis-Chalmers pumps are helping water supply engineers to cut pumping costs . . . reduce overhead . . . increase efficiencies and profits! Allis-Chalmers Pumps can help you, too, and give you dollar-and-cents savings in your plant!

Find out the facts today about getting the right kind of pump for your work! In the Allis-Chalmers district office near you is a trained pump engineer with interesting and important performance facts about pumping equipment that you should know. Get in touch with him . . . learn how much you can save . . . what modern Allis-Chalmers pumps can do for you! It Pays To Modernize With the Equipment that Pays for Itself!

1021

CENTRIFUGAL PUMP DIVISION

**ALLIS-CHALMERS**

MILWAUKEE·WISCONSIN

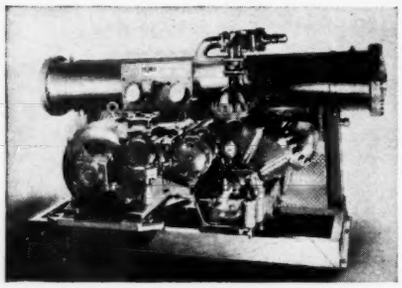
SINGLE-STAGE DOUBLE-SUCTION PUMPS • CLOSE-COUPLED SINGLE-STAGE SSUnit PUMPS • MULTI-STAGE PUMPS • PAPER STOCK PUMPS • MIXED FLOW AND AXIAL FLOW PUMPS • AND SPECIAL DESIGNS FOR UNUSUAL APPLICATIONS

six radiating arms, providing 3 driving points of contact, instead of the former 4-arm insert which provided only 2 points of contact. Folder No. FB-14W.

*Charles Bond Co, Philadelphia, Pa.*

## Refrigerating Compressor

W-TYPE is light in weight and well balanced. It can be installed on an ordinary upper floor and in locations where vibration might be a factor if special foundations were not provided. A 1-piece



casting forms compressor crankcase and houses removable, nickel-iron cylinder sleeves which are assembled in 3 pairs. One pair is set vertically. Each of the other two pairs are at an angle of 60 deg to the first. This arrangement is said to provide balance, simplified lubrication and accessibility, and permits use of short, rigid, double-throw crankshaft requiring only two main bearings. Made in sizes from 40 to 75 hp.

*York Ice Machinery Mfg Corp, York, Pa.*

## Indicating Micrometer

"COMPAR" indicating micrometer and comparator measures in 0.0001 in. Gears and racks have been eliminated from indicator mechanism in favor of knife-edge lever type. Anvil-relieving button moves back lower anvil for inserting

and removing work. When work is inserted and button released, anvil is pressed against work by light-pressure return spring, thereby insuring consistency of measurement.

*George Scherr Co, 128 Lafayette St, New York, N. Y.*

## Steam Gun

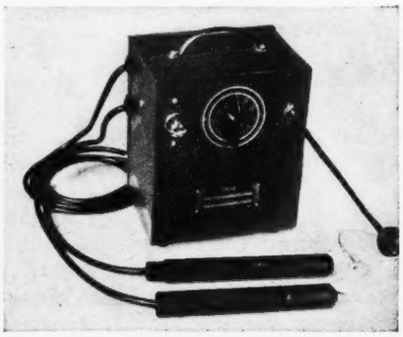
OAKITE steam gun, for removing heavy accumulations of dirt, grease and oil deposits from industrial machinery and

equipment, automatically lifts cleaning solution from floor level to a height of over 10 ft without aid of pumps, injectors, gravity feed or other auxiliary apparatus. All that is needed to operate this gun is steam and solution hoses, steam supply, and an open-top drum or other open solution container. Made in two sizes, large and small.

*Oakite Products, Inc, 22 Thames St, New York, N. Y.*

## Insulation Tester

TESTING DEVICE, for voltages up to 2500, indicates whether or not there is a short, ground or broken wire. Said to be specially suited for testing insulation of low-voltage equipment. All current-

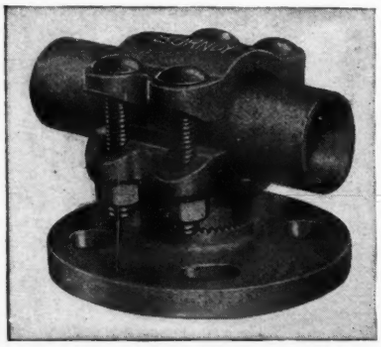


carrying parts are carefully insulated. Other safety features include: 3-wire primary cord, spring-operated cover over high-potential primary cord, and a red indicating lamp.

*Ideal Commutator Dresser Co, 1025 Park Ave, Sycamore, Ill.*

## Bus Support

IMPROVED bus support includes following features: Interlocking teeth on neck of device permit setting tubular bus at an



angle to steel structure. Finer adjustments than are obtainable through use of interlocking teeth can be obtained by slightly ovalized bolt holes in base. Tube clamping members are so arranged that either a tight fit or slide fit can be obtained.

*Burndy Engineering Co, Inc, 459 E 133rd St, New York, N. Y.*

## Valve Operator

TYPE JS Limitorque valve operator consists of a motor-driven combination helical and worm-gear reducing mechanism which bolts to a pad on side of valve yoke. Output shaft of Limitorque is connected to valve stem or yoke nut through pair of spur gears. Lost-motion device built into machine allows motor to attain full speed before stem load is

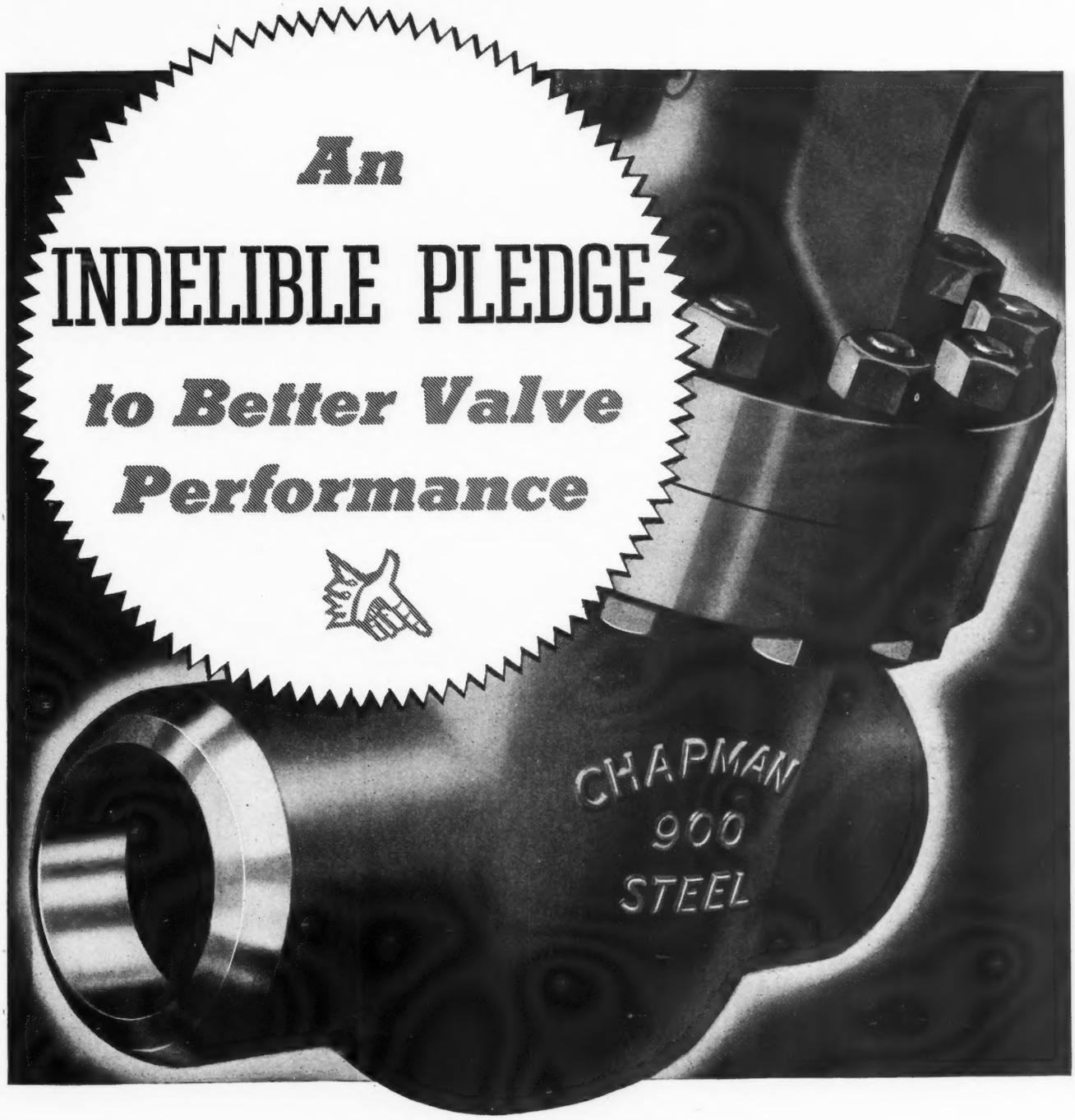
encountered. This produces a "hammer blow" at valve stem which unseats or starts valve in motion. Valve can be hand operated by turning declutch handle. ¼-hp, 110-volt, 25-to-60-cycle, single-phase universal motor (ac or dc) is standard with this operator. Full load current is 4 amp and stalled current about 15 amp. Motors of other voltages and characteristics can be supplied when desired.

*Philadelphia Gear Works, Erie Ave & G St, Philadelphia, Pa.*

## Motor-Pump Unit

"MOTOAIR" motor-pumping unit can be installed in normal mountings, or upon wall and ceiling mountings. Does not

have usual air chamber, but either vacuum or pressure is built up without pulsation or vibration. Visible oil con-




**Look for the word "Chapman"—in bold, steel letters—molded in the body of the valve. It's your guarantee of superior design, construction, character—an "indelible pledge" to long-time valve service under high temperature and pressure conditions. Gate, globe, check and angle valves bear the pledge of Chapman—valves with all types of operating mechanisms—valves for temperatures up to 1000° F and pressures to 2500 lbs.**

**Available In These Alloys**

Carbon Steel
Carbon Molybdenum Steel
Chrome Nickel Steel
Nickel Steel
Chrome Molybdenum Steel
Chrome Nickel Molybdenum Steel

*Write for complete catalog.*

**THE CHAPMAN VALVE MFG. CO., INDIAN ORCHARD, MASSACHUSETTS**

# CHAPMAN POWER PLANT VALVES

trol and filter designed to eliminate spraying of oil that frequently causes spoilage by soiling when pump is run intermittently. Made in many sizes for all standard variations in electrical service, and is said to give more horespower per unit of electrical input than other motor pumps.

*New Jersey Machine Corp, Hoboken, N. J.*

## Rectifier Unit

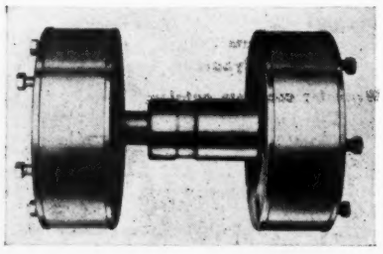
SMALL-CAPACITY, permanently evacuated rectifier unit consists of a glass bulb, resiliently mounted, in a readily accessible trunk-type framework located waist-high in upper portion of cubicle chamber. Lower portion contains cooling fan and small panel supporting ignition and

excitation devices. Necessary transformers and circuit breakers that go with unit can be placed adjacent to cubicle. Made in sizes ranging from 50 kw at 250 volts to 300 kw at 600 volts, or higher, for conversion of dc to ac.

*Allis-Chalmers Mfg Co, Milwaukee.*

## Flexible-Coupling Drive-Shaft Units

"MORFLEX" radial coupling drive-shaft units consist of two standard Morflex couplings with a slip-joint drive shaft between, for drives requiring greater flexibility than can be accommodated with a single coupling. Slip joint is full-



spline construction, grease tight, and slides freely under load. Shaft assembly is balanced for smooth operation and is adapted for use on dynamometer drives and others in which endwise float may be required. Two types made; short coupled, illustrated, and long coupled for applications where more distance is required between couplings. Both types made in ratings of 2 to 27 hp at 100 rpm.

*Morse Chain Co, Ithaca, N. Y.*

## Clamp Ammeter

MODEL 633 bakelite-encased ac clamp ammeter combines 6 ranges in one instrument, and will measure current flow through conductors (insulated or non-insulated) up to 2¼ in. in diameter.

Instrument is equipped to measure low as well as high values. Actual full scale ranges are 10/, 25/, 50/, 100/, 250/ and 500/ amp. Any one of these 6 ranges may be selected by easily operated range changer at the thumb position.

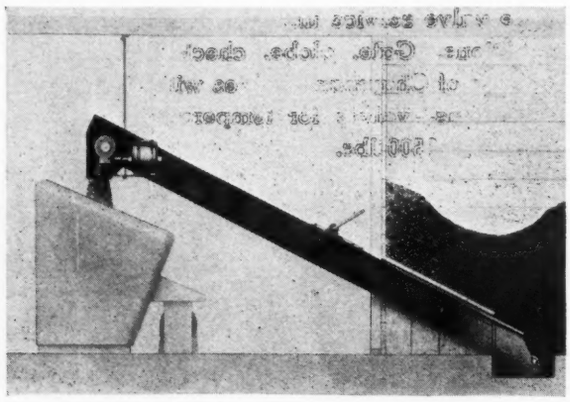
*Weston Electrical Instrument Corp, Newark, N. J.*

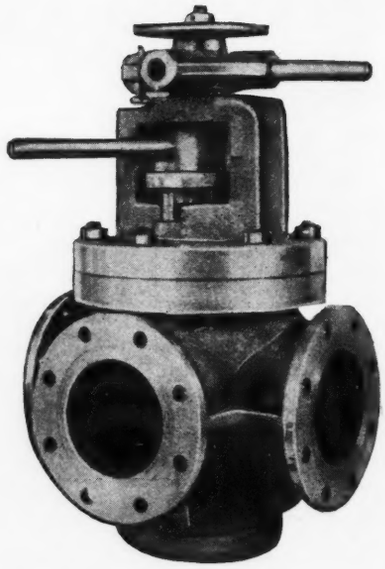
## Heavy-Duty Wrenches

LINE of heavy-duty box wrenches with interchangeable tubular handles are made in both double-offset and 15-deg-angle types. Are dropforged of chrome-alloy steel, carefully heat treated and

heavily plated, with polished heads. Each type is made in seven sizes with double-hexagon openings ranging from 1⅝ to 2¼ in.

*Bonney Forge & Tool Works, Allentown, Pa.*





## Brass Valves

LINE of 3-way brass lift-plug valves, for air, water, oil and gas at pressures to 150 lb and temperatures below 400 F, is made in sizes from 1¼ to 1¾ in. Three styles of port arrangement: Style *D* permits flow from either end and out side opening, or vice versa; Style *E* permits flow from left-hand end and out side opening or straight through; *F* permits flow from right-hand end out side opening, or straight through. Direction of flow is changed by quarter turn of operating lever.

*Homestead Valve Mfg Co, Coraopolis, Pa.*

## No-Rust Primer

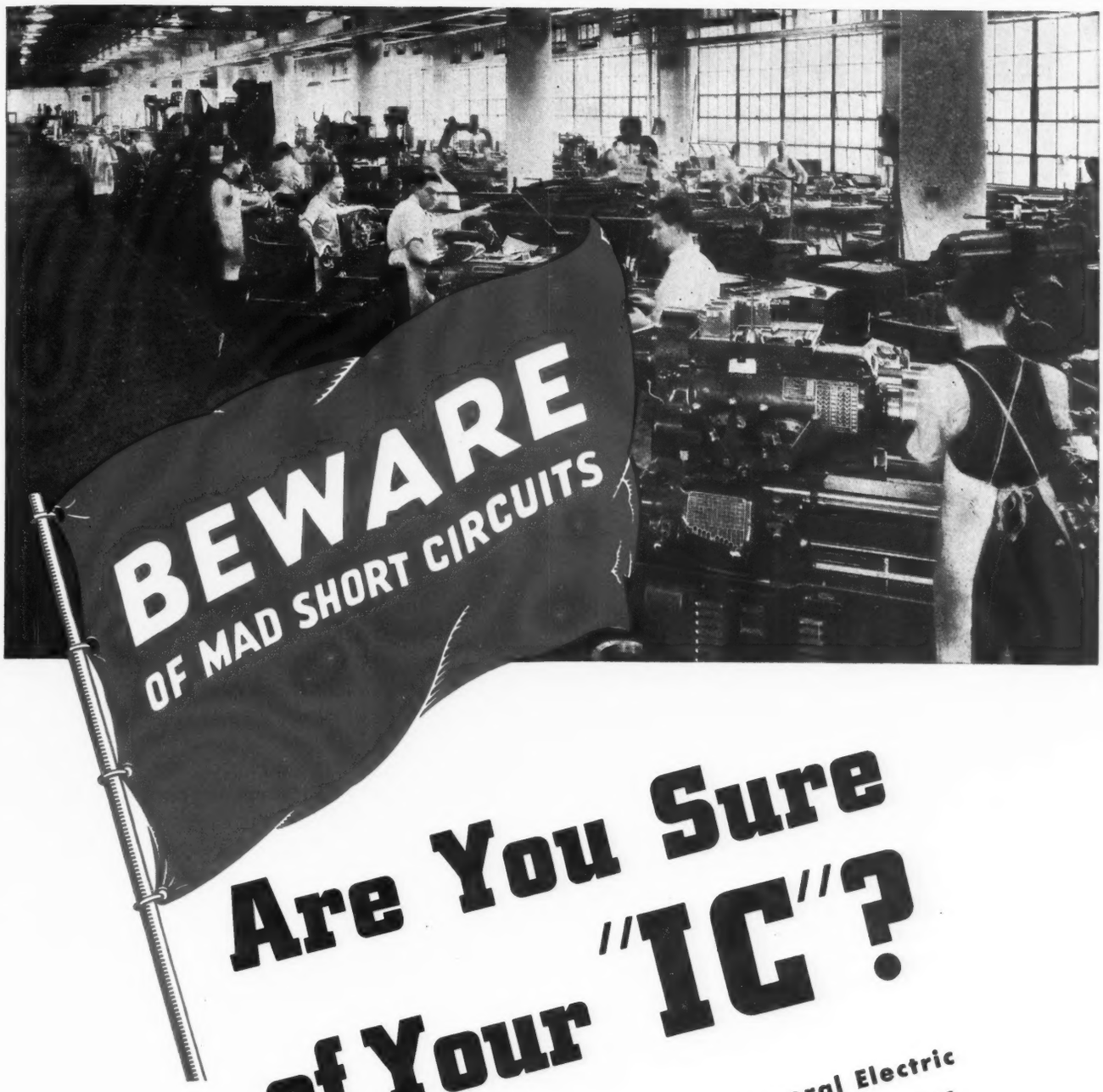
"VALDURA" no-rust primer, made from tung oil and other sealing oils, is said to choke rust and prevent its spreading or bleeding through top coat of paint. Manufacturer believes that any high-grade paint can be satisfactorily applied over this primer, thus eliminating need for sandblasting or cleaning rusty surfaces before painting.

*American Asphalt Paint Co, 43 E Ohio St, Chicago, Ill.*

## Coal Loader

AUTOMATIC coal loader to fill stoker hoppers has capacity up to 10 tons per hr. Can be adjusted to meet stoker - room requirements; sole factor governing loader length is distance from coal pile to hopper. Illustrated is ceiling-suspended model; another model is supported by floor stand. Both can be furnished for either right- or left-hand operation. Loader is operated by a ½-hp motor.

*D J Murray Manufacturing Co, Wausau, Wisconsin.*




# Are You Sure of Your "IC"?

**BEGINNING next month, the General Electric Company will bring you, in these advertising pages, a series of messages on a vital problem in industry. They will explain the importance of a clear understanding of "I C," its relation to the safety of your personnel and equipment—and the solution of this problem.**

**GENERAL ELECTRIC**

890-82

# When I Am Gone . . .

*Here is a toast I want to drink to a fellow I'll never know,*
*To the fellow who's going to take my place when it's time for me to go.*
*I've wondered what kind of a chap he'll be and wished I could take his hand*
*Just to whisper, "I wish you well, Old Man," in a way that he'd understand.*
*I'd like to give him a cheering word that I've longed at times to hear.*
*I'd like to give him a helping hand when never a friend seems near.*
*I've learned my lesson by sheer hard work, and I wish I could pass it on*
*To the fellow who'll take my place some day, some day when I am gone.*

This poem is another old-time favorite of mine that I've been wanting to pass along. I don't know who wrote it, but he certainly put down some of the truest words ever penned.

It's easy to commit your successor to a lifetime of the same troubles you've had; to say, "Just wait 'til I'm gone, and he'll find out . . ." But that does nobody any good; in fact, usually causes trouble all around. It's far better to realize that there's a job to be done, a big job, and to try to get as much of it done as possible —and done right—before the time comes to check out. It's a heck of a lot more satisfying 'way down inside to remember Cecil Rhodes' words, "So much to do, and so little time in which to do it!" And to wish luck to the fellow who is to come . . .

George Edwards

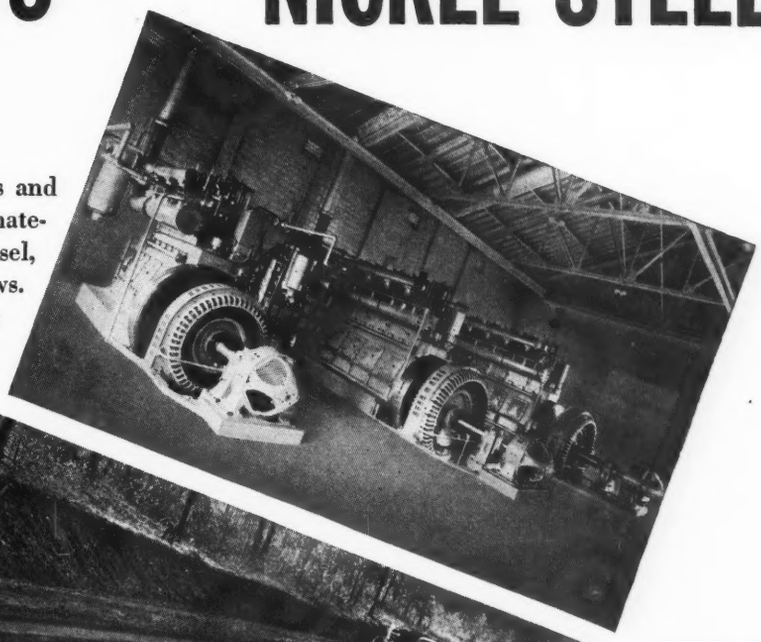
*Engineer*

# FOR VITAL DIESEL PARTS THERE ARE APPROPRIATE NICKEL STEELS

Diesel economy—born of high pressures and high temperatures—cruelly tests engine materials. To foresee the useful life of a Diesel, look at its stout heart and bones and sinews.

Your safe guide, and safeguard, is liberal use of Nickel alloy steels in *all* vital parts. As is the practice of three leading makers whose Diesel units are pictured on this page.

Look, too, at this chart which lists 25 Diesel parts and the particular Nickel alloy steels recommended to serve best in these highly stressed units. Nickel steels retain strength at high temperatures, maintain close clearances for long periods. For more complete information about other advantages of Nickel alloys in Diesel service, please address your inquiry direct to:



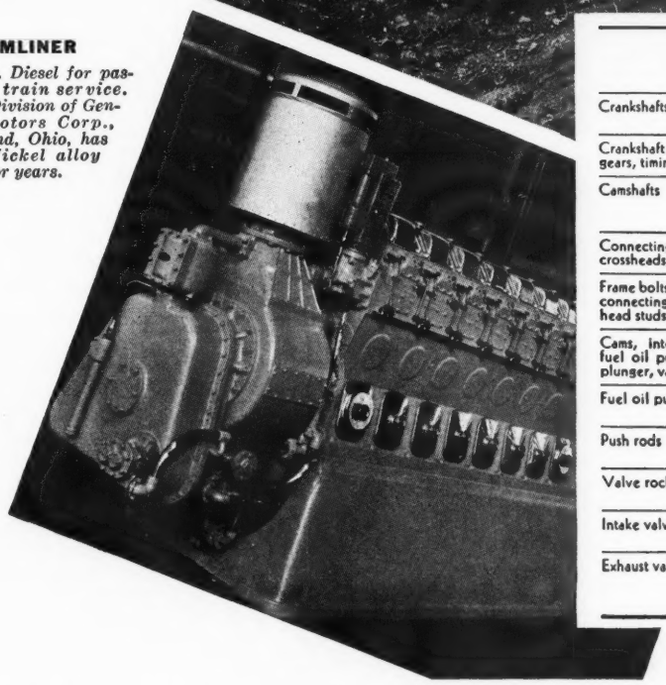
**CENTRAL STATION**

*Three municipal power plant generators driven by 250, 415 and 500 h.p. Worthington Diesels. Worthington Pump & Machinery Co., Harrison, N.J., depends upon Nickel steels.*

**HIGHWAY...** *Mastering mud, levelling hills, this Allis-Chalmers is pulling an experimental grader. Allis-Chalmers Mfg. Co., Milwaukee, Wis., uses Nickel alloy steels in numerous types of equipment from giant turbines to small farm implements.*

**STREAMLINER**

*600 h.p. Diesel for passenger train service. Diesel Division of General Motors Corp., Cleveland, Ohio, has used Nickel alloy steels for years.*



| PART | SERVICE REQUIREMENTS | STEELS RECOMMENDED | TREATMENT |
|---|---|---|---|
| Crankshafts | Strength, toughness, good fatigue resistance | SAE 4340<br>SAE 3240 | Quenched and tempered |
| Crankshaft pinions, cam-shaft gears, timing gears | Strength with high wear resistance | SAE 3250 | Quenched and tempered |
| Camshafts | Wear resistant surface, tough core | SAE 2315<br>SAE 4615<br>SAE 3115 | Casehardened |
| Connecting rods, piston rods, crossheads, exhaust valve stems | Strength, high toughness and ductility | SAE 2330 | Quenched and tempered |
| Frame bolts, tie rods, stay bolts, connecting rod bolts, cylinder head studs, etc. | Strength, high toughness and ductility | SAE 2330<br>SAE 3130 | Quenched and tempered |
| Cams, integral, cam rollers, fuel oil pump plunger, valve plunger, valve barrels | High wear resistance with strong and tough core | SAE 3312 | Casehardened |
| Fuel oil pump lever | High wear resistance with strong and tough core | SAE 3215 | Casehardened |
| Push rods | High compressive strength and toughness | SAE 2345 | Quenched and tempered |
| Valve rockers | Strength, high toughness and ductility | SAE 4340<br>SAE 2330 | Quenched and tempered |
| Intake valves | Moderate strength, resistance to wear and deformation | SAE 3140 | Quenched and tempered |
| Exhaust valves, seats | Resistance to elevated temperatures and to corrosion from exhaust gases | 21% Cr, 12% Ni | (Special heat treatment) |

**THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.**

# COMPACT CONVENIENT COST-CUTTING

## CONTROL FOR A WIDE VARIETY OF APPLICATIONS

In a huge majority of pressure control jobs *expensive* instrumentation is unnecessary. These simple, sturdy instruments provide the accurate flexible control most jobs require. Though inexpensive to buy, operate and maintain there is nothing "cheap" about them. On the contrary they are excellent examples of the Mason-Neilan policy of giving *More for Your Money.* Features include throttling range of 1 to over 30%; reversible operation; full indication; micrometer setting; ranges between 0 and 500 lbs.

Use these practical controllers on reducing stations, pumps, desuperheaters, water lines and many other services. Get accurate control plus compactness and convenience at low cost.

*Write for Bulletin No. 2500.*

**These controllers may be mounted on wall or panel for remote control —or directly on the control valve as illustrated.**

**1186 ADAMS STREET**
**BOSTON, MASS., U.S.A.**

MASONEILAN

New York Philadelphia Pittsburgh Buffalo Chicago Toledo St. Louis Tulsa Houston Los Angeles


# Engineers' Books

## Gas Analysis

GAS ANALYSIS (1st Edition—1938). *By A McCulloch, University of Manchester. Published by H F & G Witherby Ltd, 326 High Holborn, London WC 1. 166 pages, 5½x8½ in., 38 illustrations, cloth binding. Price 7 shillings, sixpence (about $1.85).*

Written for the student in fuel-technology laboratory courses, this little book covers in a straightforward and thorough fashion British practice in gas analysis.

Principal material describes construction and manipulation of five well-known gas analysis devices, with a word on the special applicability of each. Additional chapters on miscellaneous determinations, including calorific value, and on sampling of gases and use of absorbents, widen the scope of the book.

## Steam and Gas

STEAM AND GAS ENGINEERING (3rd Edition—1938). *By T E Butterfield, B H Jennings, and A W Luce; Lehigh University. Published by D VanNostrand Co, Inc, 250 Fourth Ave, New York, N. Y. 490 pages, 6x9 in., 332 illustrations, cloth binding. Price $4.50.*

This third edition brings the text up-to-date in a rapidly changing field. The treatment remains free of higher mathematics and is liberally illustrated from current practice. Following presentation of some typical plants to show the kind of apparatus used, fuel and combustion are considered as basic to any plant design.

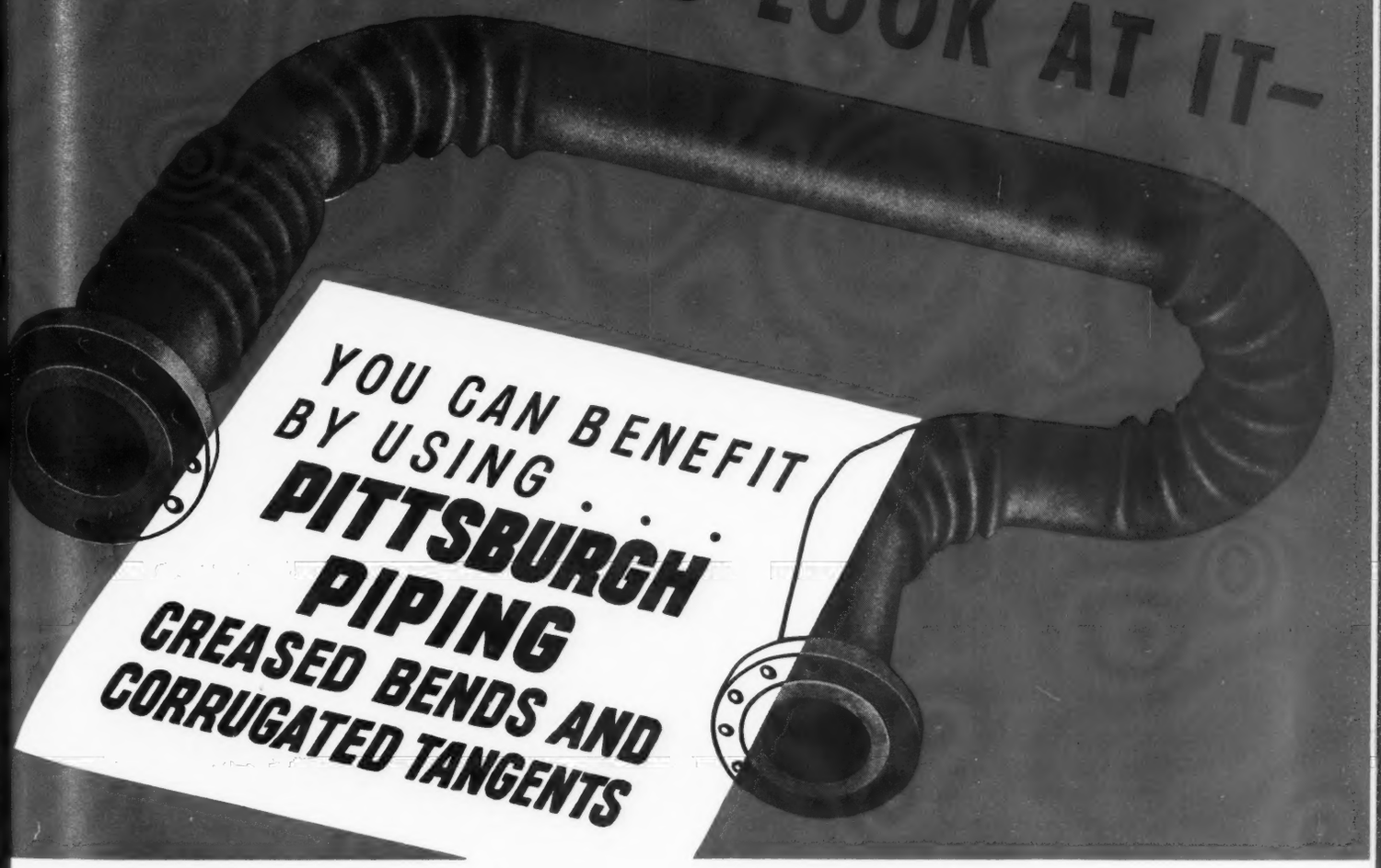
A return to theory brings in chapters on energy laws, steam properties, and steam cycles, as a basis for a discussion of steam boilers and auxiliaries. This same coupling of necessary theory and illustrative practice continues through sections on gas engines, steam engines and turbines, oil engines, and refrigeration. While the broadness of the field covered prevents exhaustive treatment of any phase, this very broadness should make the book useful to students and engineers who want to brush up on fundamentals.

## Refrigeration

THEORY OF MECHANICAL REFRIGERATION (1st Edition—1938). *By N R Sparks, Pennsylvania State College. Published by McGraw-Hill Book Co, 330 W 42nd St, New York, N. Y. 225 pages, 6x9 in., 53 illustrations, cloth binding. Price $3.00.*

Based on the idea that, for the student, descriptive and empirical material is best learned by experience, this book is confined to a complete and logical presentation of refrigeration fundamentals. It should prove equally helpful to the

# NO MATTER HOW YOU LOOK AT IT—



YOU CAN BENEFIT BY USING . . .

## PITTSBURGH PIPING CREASED BENDS AND CORRUGATED TANGENTS

*from*

### THE DESIGN ENGINEER'S POINT OF VIEW . . .

Bending moments caused by thermal expansion are greatly reduced when Pittsburgh Piping Creased Bends and Corrugated Tangents are used because of their inherent flexibility. Your design problems are further simplified by our ability to accurately prefabricate in one piece Creased Bends and Corrugated Tangents into piping assemblies of any practical design.

*from*

### THE OPERATING ENGINEER'S POINT OF VIEW . . .

The more compact arrangement of piping made possible by the use of Pittsburgh Piping Creased Bends and Corrugated Tangents can lower your maintenance work and improve operating efficiency by providing more easily accessible valves and higher head clearances. Auxiliary equipment can be conveniently located without danger of excessive end reactions.

*from*

### THE MANAGEMENT'S POINT OF VIEW . . .

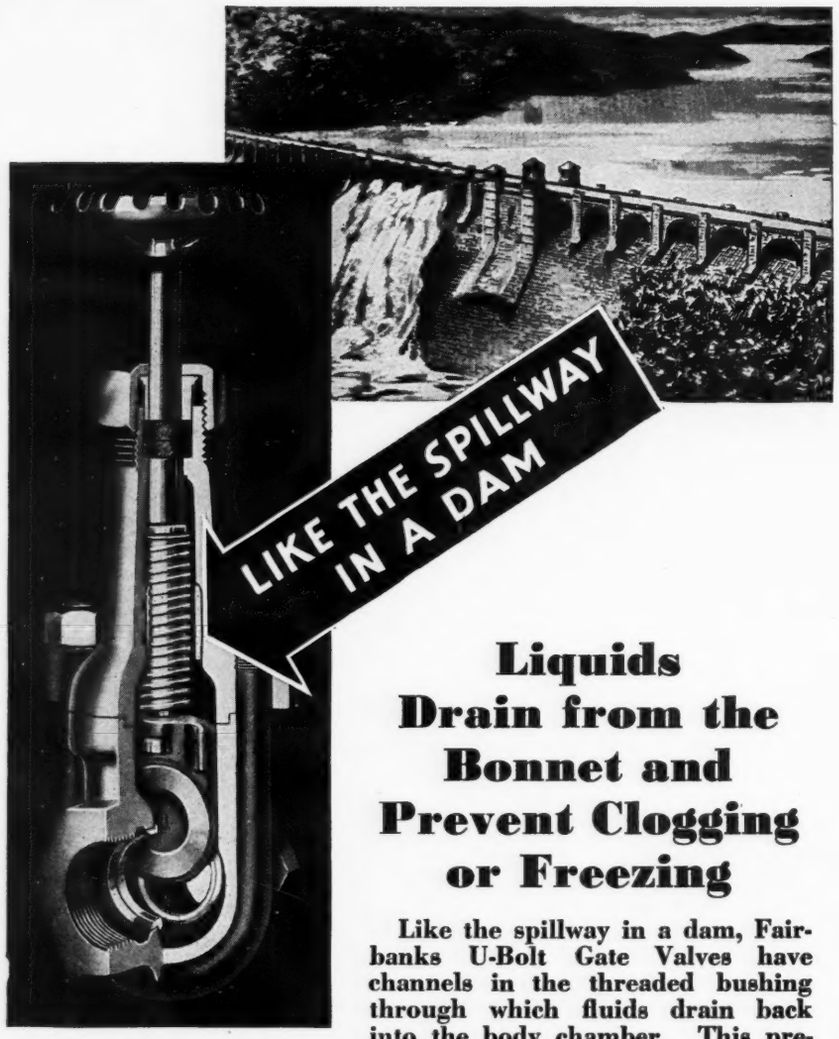
When you are considering the modernization of your existing power system, keep in mind that space-saving features of Pittsburgh Piping short-radius Creased Bends and superflexible Corrugated Tangents often permit the installation of a vastly more complex system in an existing structure, thus eliminating the necessity of expending capital for a new building.

**PITTSBURGH PIPING & EQUIPMENT CO., 10 FORTY-THIRD STREET, PITTSBURGH, PA.**

BRANCH OFFICES IN PRINCIPAL CITIES

*Pittsburgh Piping*

**CREASED BENDS WITH CORRUGATED TANGENTS**




**Liquids Drain from the Bonnet and Prevent Clogging or Freezing**

**Like the spillway in a dam, Fairbanks U-Bolt Gate Valves have channels in the threaded bushing through which fluids drain back into the body chamber. This prevents clogging or freezing and keeps the stem threads clean.**

**The long bushing, having more threads, insures easy operation and long wearing service.**

**The large rugged bronze stem has full cut Acme threads. The knife-edge wedge cuts through sediment and heavy fluids.**

**The U-Bolt allows the valve to be taken apart and again assembled in minimum time and holds the high-pressure gasket in a perfect joint without leakage.**

**Stuffing box, being very deep and packed with the best grade of formed asbestos packing, insure a pressure tight seal. It can be repacked with the pressure on when valve is wide open or tight shut.**

**Body and bonnet are made of high-test alloy iron having an average tensile strength of 40,000 lbs. per sq. in. of sectional area.**

**Distributors everywhere sell these valves. Try one today.**
***Write for Booklet.***

**THE FAIRBANKS COMPANY**
***Valves, Dart Unions, Hand Trucks and Wheelbarrows***
**397 LAFAYETTE ST., NEW YORK, N. Y.**
**Boston, Pittsburgh—Distributors in Principal Cities**
**Factories: Binghamton, N. Y., Rome, Ga.**

**FAIRBANKS**
**U-BOLT GATE VALVES**

engineer, wise in the practical phases, who wants to improve his knowledge of refrigeration theory.

Starting with basic heat principles, the author covers general refrigeration principles, and then discusses air and vapor systems. Further chapters consider special parts of the field, such as use of solid $CO_2$ as a cooling medium, multiple-effect vapor compression, and absorption refrigeration. Refrigeration in air conditioning, water-vapor refrigeration, absorption, and the heat pump, are discussed in concluding chapters. Tables of properties of ammonia, and Mollier charts for ammonia and $CO_2$ are also included, in a section of tables and charts.

## Motors

FRACTIONAL-HORSEPOWER ELECTRIC MOTORS (1st Edition—1939). *By Cyril G Veinott, Design Engineer, Small-Motor Engrg Dept, Westinghouse Electric & Mfg Co. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York, N. Y. 431 pages, 6x9 in., 315 illustrations, 22 tables, cloth binding. Price $3.50.*

For the first time, we have a comprehensive presentation of descriptions, data and diagrams of the major types of fractional-horsepower motors, for practical use by all concerned with design, manufacture, use and repair of these motors. Descriptions of each type include an explanation of the elementary principles of operation, usual forms of construction, speed-torque characteristics, and schematic and detailed diagrams of connections.

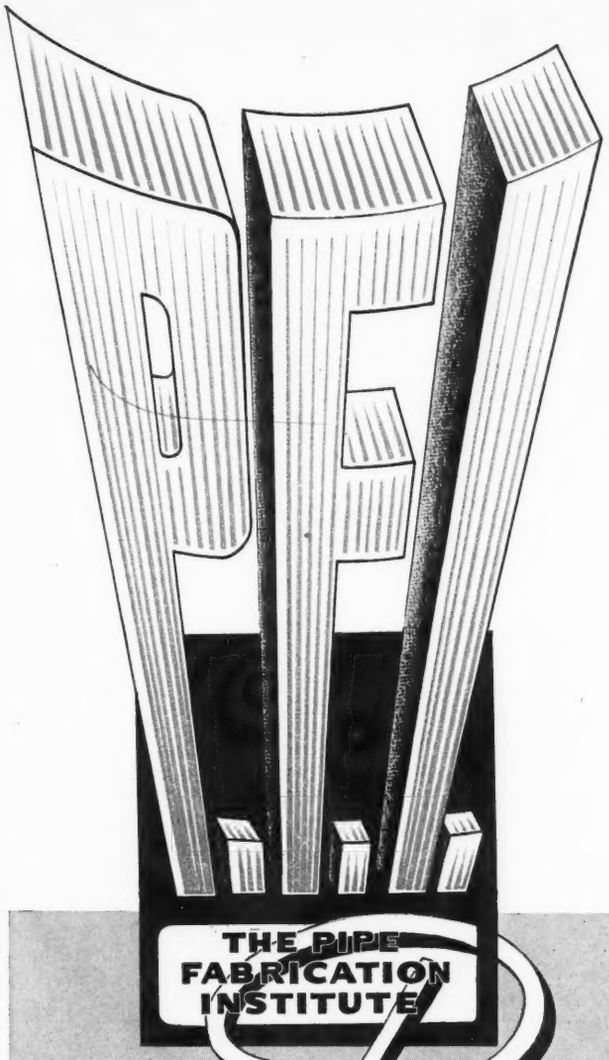
Subjects covered include the story behind the nameplate, what makes an induction motor run, single-phase induction-motor windings and connections, split-phase motors, capacitor motors, repulsion motors, universal motors, shaded-pole motors, polyphase induction motors, synchronous motors, direct-current motors, starting and protective devices and testing fractional-horsepower motors.

The treatment is practical, mathematical formulas being eliminated almost entirely. The book is written primarily to serve the needs of practical men engaged in installation, maintenance and repair work.

## Air Conditioning

AIR CONDITIONING (2nd Edition—1938). *By J A Moyer and R U Fittz. Published by McGraw-Hill Publishing Co, 330 W 42nd St, New York, N. Y. 455 pages, 6x9 in., 202 illustrations, cloth binding. Price $4.00.*

The first chapter of this new edition has been completely rewritten to bring it into line with current practice and to simplify the presentation of air-conditioning principles. A new chapter gives data on sun effect, heat transmission through building materials, and methods of calculating and selecting




Recognizing the always changing piping practices necessitated by continuous technical development in steam generation and in industrial processing, leading members of the Pipe Fabrication Institute have long made piping research an important and integral part of their business. Such research is extremely broad in scope and has found the correct answers to many piping problems having to do with pressure welding, bending, lap jointing and forming, and the selection of suitable materials. The qualified piping fabricator is always glad to make this experience freely available to help you secure piping that exactly suits your requirements from an engineering and an economic standpoint.

*Research*

**PROVIDES YOU WITH**

# BETTER PIPING

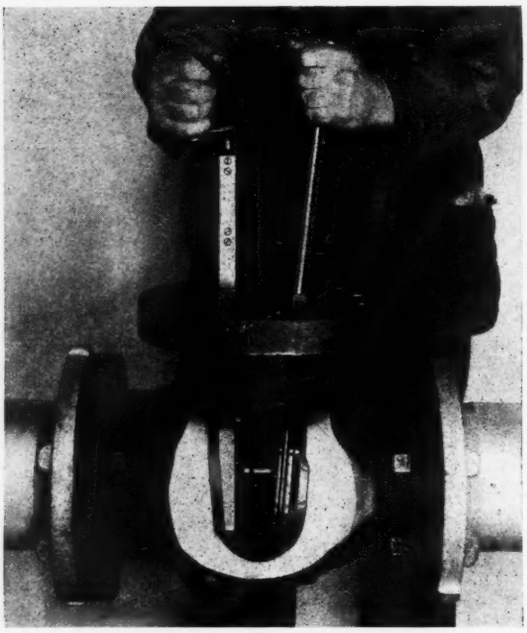
**THE PIPE·FABRICATION INSTITUTE**

P.F.I. THE PIPE FABRICATION INSTITUTE

*Devoted to the Technical and Economic Problems in Piping*

1108 • PITTSBURGH, PA.

# VALVE RESEATING MACHINES ARE NEEDED IN *EVERY* PLANT

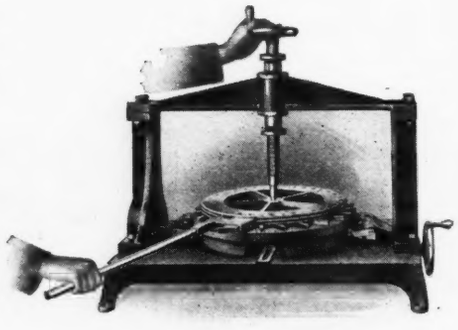


## YES! YOU CAN HAVE TIGHT GATE VALVES

Stop leakage in gate valves—insure a perfectly tight fit—by refacing seats and gates exactly alike with the Dexter Gate Valve Reseating Machine.

As specialists in solving the problems involved in valve reseating, we have developed this machine to handle the job quickly, easily and effectively. The work is done by the Dexter with the valve in place—which means a tremendous saving in time and labor.

It will pay you to stop waste by refacing leaky gate valves now. Don't wait until costly replacements are necessary. Put a Dexter to work and it will pay for itself over and over again. Available for valves from 1½" to 42". You'll be interested in the details in our catalog No. 24. Write for a copy today.



Investigate Dexter Machines for refacing pump valve seats and for reseating globe valves. We are also manufacturers of Swendeman Automatic Separators for removing water and oil from compressed air lines.

THE LEAVITT MACHINE CO.
10 EAST RIVER ST. ORANGE, MASS.
Canadian Distributors:—
The Canadian Fairbanks-Morse Company Limited
15 Branches Throughout Canada


unit conditioners. Other chapters have been extensively revised, notably that on automatic controls, and many illustrative design problems have been recalculated.

AIR CONDITIONING. HEATING AND VENTILATING (1st Edition—1938). *By J Ralph Dalzell, Head, Architectural Engrg Dept, American School, and C L Hubbard, Consulting Engineer. Published by American Technical Society, Drexel Ave at 58th St, Chicago, Ill. 571 pages, 5½x8½ in., 300 illustrations, cloth binding. Price $4.00.*

Fourth book in a series on air conditioning, this text is devoted to heating and ventilating aspects. It covers, in straightforward style, and with ample use of illustrations, fundamentals, comfort standards, insulation, boilers, ventilating systems, radiators, steam and hot-water heating systems, controls, vacuum systems, fans, firing equipment, air-conditioning appliances and applications, cooling methods and loads, design of ducts.

MAINTENANCE AND INSPECTION OF STEAM-TURBINE GENERATING UNITS AND AUXILIARIES (1938). *By Hans Dahlstrand, Engineer in Charge, Steam Turbine Dept, Allis-Chalmers Mfg Co. Published by Allis-Chalmers Mfg Co, Milwaukee, Wis. Available on request.*

This is a paper presented before the Electrical Section of the Wisconsin Utilities Ass'n and deals with both the steam and electrical ends of turbine generators. Maintenance of each part of the unit from throttle valve to exciter are considered.

## Current Comment

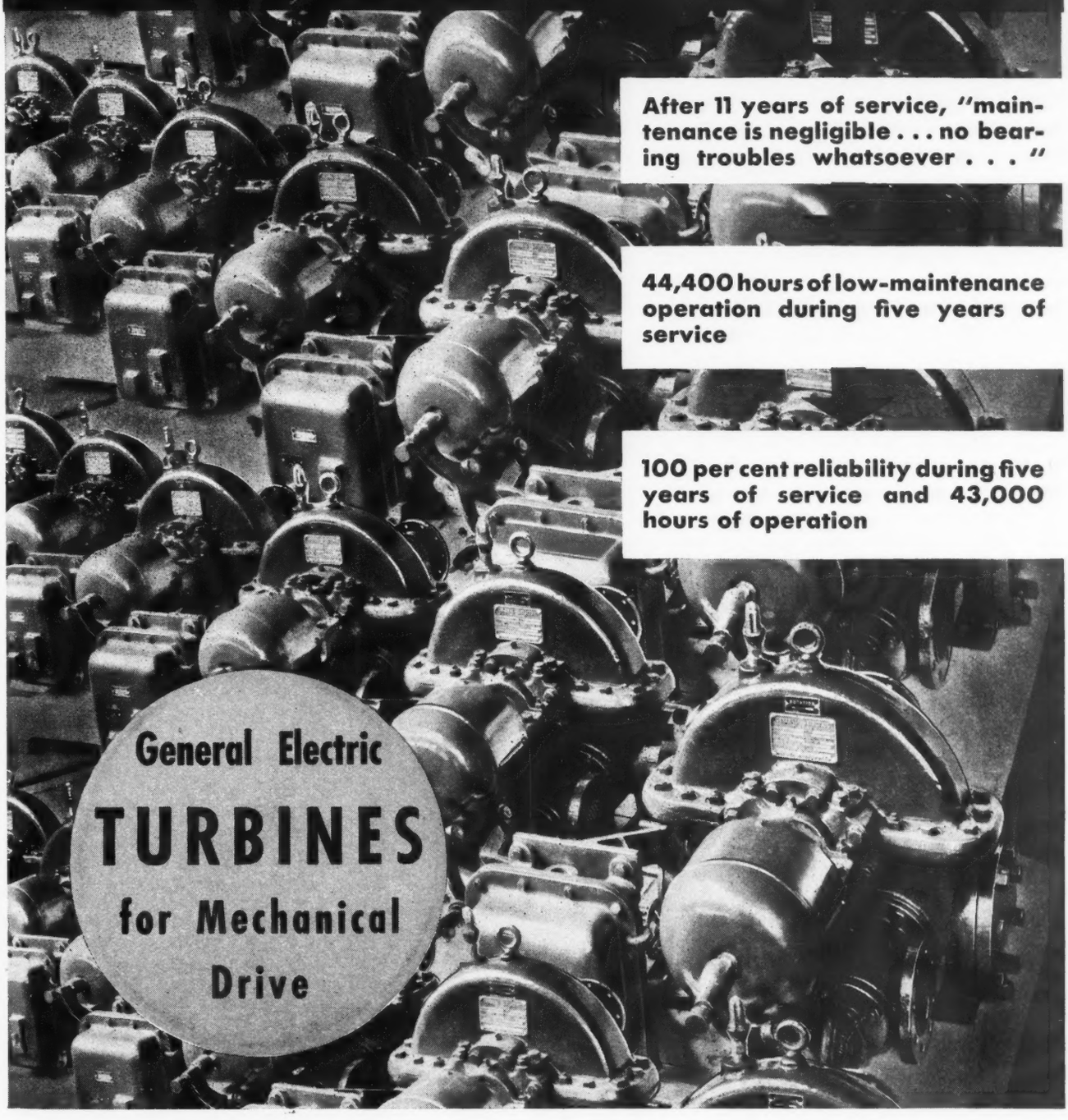
(*Continued from page* 108)

and quality. Having done this, they put in a reciprocal-relations department which overrides the decisions of buyer, inspector and engineer, and places business merely because of the suppliers' previous purchases from their company. This policy results in frequent strained industrial relations since no one can buy in a volume to satisfy the reciprocator. Not only that, but the distribution is never fair from the seller's point of view.

Reciprocal buying results in higher prices, since the reciprocator cannot get the best price available. It results in lower quality, since the reciprocator cannot insist on quality. It results in lack of standardization, which enormously increases cost of upkeep. Governmental attempts to "cure" such evils might be worse than the evils themselves, so industry must attack this problem itself. In the hands of governmental regulation for its elimination, a waste will be turned into regimentation from which industry perhaps can never recover.

*Cleveland, Ohio* J F LINCOLN
*Lincoln Electric Co*

# READY TO REPEAT RECORDS LIKE THESE


After 11 years of service, "maintenance is negligible . . . no bearing troubles whatsoever . . . "
44,400 hours of low-maintenance operation during five years of service
100 per cent reliability during five years of service and 43,000 hours of operation
General Electric
TURBINES
for Mechanical Drive

Thousands of G-E mechanical-drive turbines have turned in records like these—and that's your best assurance that G-E turbines will give you similar service. Make your next purchase of turbines General Electric and prove to yourself how superior design—reducing bearing wear and bucket erosion—keeps G-E turbines young longer and helps you to cut operating costs. Consult your nearest G-E office, or write General Electric, Schenectady, New York.

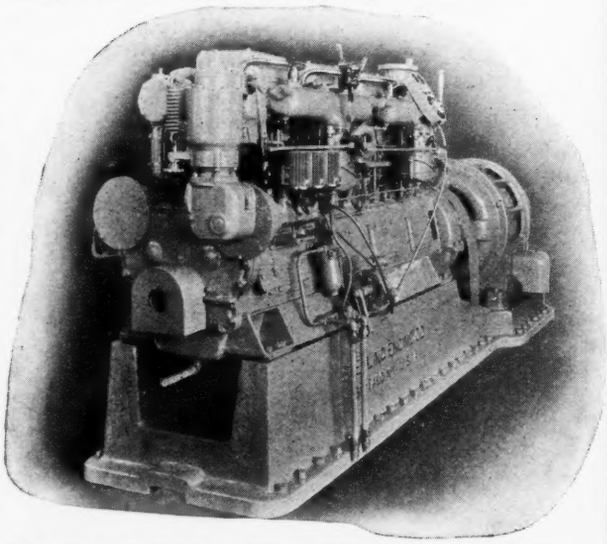
**GENERAL ELECTRIC**

720-303

# QUICK STARTING ENGINES

Capable of accepting immediate load
Extremely accurate governing
With Underwriters' Laboratory approval
Smooth under load, vibration eliminated
Are essential requirements for
Emergency sets for public building installations:

125 K. W. General Electric Generator direct connected to 1200 R.P.M. Sterling Dolphin 8-cylinder 240 H.P. engines, mounted on spring supported bedplate.



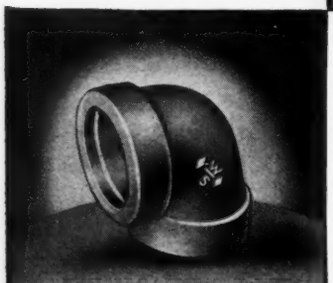
*Sterling Engines qualify for most important emergency service.*

## STERLING ENGINE COMPANY

Home Office and Plant, 1270 Niagara Street, Buffalo, New York.
DEPT. C-1
Branch Office, 900 Chrysler Bldg., New York, N. Y.



# W-S FORGED STEEL FITTINGS *for* HIGH TEMPERATURE HIGH PRESSURE SERVICE




Wherever pipe lines carry steam, water, oil, gas or ammonia—under high pressures and temperatures—you can depend on W-S Forged Steel Fittings for safety, long life and low maintenance.

W-S Fittings are bored from solid forgings with openings equal in area to the bore of the pipe, thus assuring free flow. Walls are of uniform thickness and because of the forging process are of dense structure, free from defects.

W-S Fittings are available in Welding and Screw End Types in a wide range of sizes. The Watson-Stillman Co., Roselle, N. J.

WATSON W-S STILLMAN


# Readers' Problems

(*Continued from page* 97)

age or other losses, this water should be degasified with some form of deaerating heater followed with sodium-sulphite treatment to remove any residual oxygen. (3) Scale or sludge forming impurities in water supply are of slight importance unless water is changed frequently or much makeup is needed. When this is the case, water must be conditioned to prevent throwing down deposits that might interfere with heat transfer in boilers and radiators, or cause obstruction in piping.

As far as the small household or factory system is concerned, the only possible justification for periodic drainage other than when maintenance is required, is to remove accumulations of rust, metallic scale, core sand, pipe-joint compound, grease, and like debris that should have been taken care of immediately following construction of the system. Such an initial cleaning is easily done by dissolving soda ash in the water for filling the boilers and system. This solution is circulated during the first week of operation after which the system is drained and refilled with fresh water. Instructions covering this procedure should always be included in the original specifications.

*Roancke, Va.* S H COLEMAN

## Draining Is an Error

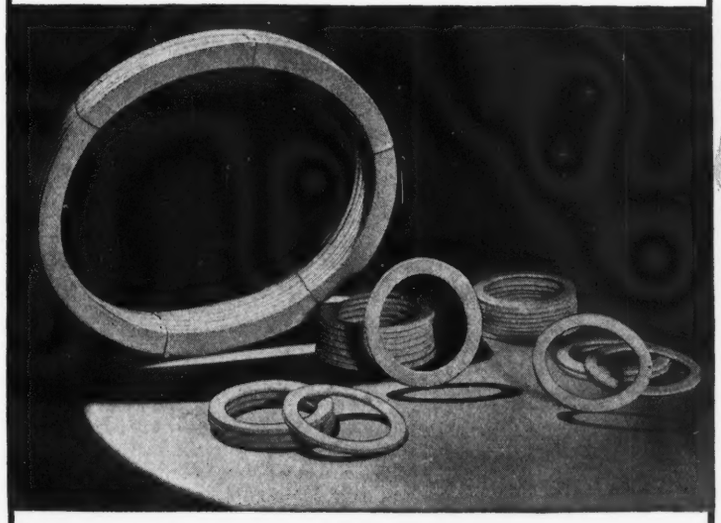
WHEN A HOT-WATER heating system is drained, water in most cases will be somewhat dirty and may carry a considerable amount of sludge. This leads many people to the erroneous conclusion that systems should be drained at regular intervals. While the system is new, it is wise to flush it out once or twice to remove foreign matter and dirt invariably present in new pipes, radiators and boilers. Circulation of water will carry most of this material down to the boiler whence it can be removed by draining and flushing. After that, the system should be refilled with fresh water and not drained again unless there are leaks, or the building is to be left unoccupied during cold weather.

Once a new hot-water system has been cleaned, the later formation of sludge is due to two separate causes. In the first place, fresh water practically always contains bicarbonates, known to the steam engineer as temporary hardness. These bicarbonates gradually break down when water is heated, forming carbon dioxide and a muddy precipitate that may or may not remain suspended in the water. This process will continue until all bicarbonates in the water have broken down. Evidence of this is the fact that "air" will continue to collect in some of the radiators long after the original air in the system has been expelled. This air is really a mixture of carbon dioxide, air, and probably some hydrogen.

The other factor responsible for dirty water in a heating system is corrosion,

# Garlock 604

## FOLDED ASBESTOS GASKETS



Skiing . . . skating . . . ballet dancing . . . or in any crowd, one girl usually *stands out*. She has *something* the others haven't got. When it comes to gaskets for boiler manholes and handholes GARLOCK 604 Folded Asbestos Gaskets *stand out*—because they are made by skilled craftsmen from highest grade materials to rigid specifications. Try GARLOCK 604's.

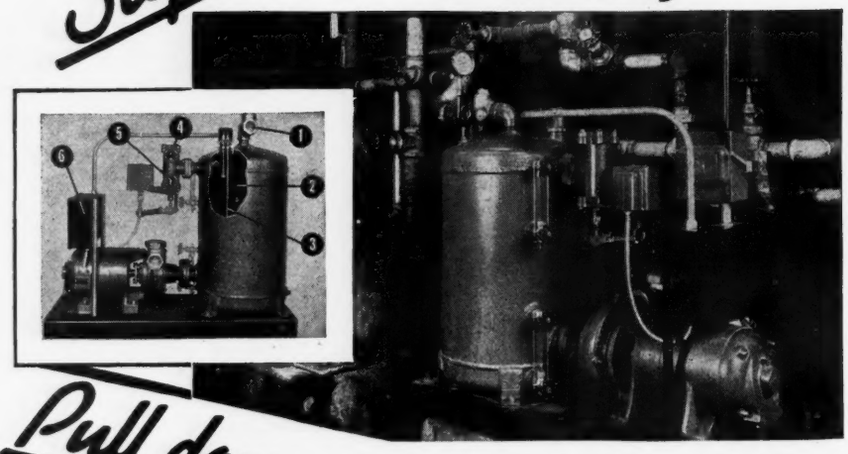
THE GARLOCK PACKING CO., PALMYRA, N. Y.

In Canada: The Garlock Packing Co. of Canada Ltd., Montreal, Que.

*One* ALWAYS STANDS OUT

GARLOCK

# Step up your boiler feeding efficiency




# Pull down your pumping costs

WHEN we first conceived this way of combining all the advantages of a boiler return trap and a boiler feed pump in one self-contained unit, the idea looked almost too good to be true. But now installation after installation has proved that the Johnson Pressure Equalizing Boiler Feed Pump literally revolutionizes the feeding of boilers up to 150 hp.

This better method is illustrated above — a well-built, ready-to-go unit, consisting basically of a condensate receiver, motor-driven pump, and automatic valve arrangement which carries out its ingenious operating principle.

Its operation is covered by the numbered illustration. Returned condensate is piped to the inlet (1) and flows into the receiver (2) until the level rises to a point where it completes a circuit through the electrodes (3). This circuit opens an electric valve and admits boiler pressure to the receiver through the inlet (4), at the same time starting the pump which runs until the contents of the receiver are pumped into the boiler. The pressure in the receiver is then automatically relieved through the outlet (5) which may be exhausted into a separate receiver to economize heat. This cycle of operation has a number of important advantages:—

## A big power saving—

With boiler pressure on the inlet of the pump (equalizing it with the boiler pressure, as in a return trap) it is only necessary to pump against the low static head of the boiler. As a result, a 1 hp. motor, driving a simple centrifugal pump, takes care of a 150 hp. boiler operating at 125 lbs.—a job that would normally require from seven to ten times more power.

## A big gain in thermal efficiency

Likewise, by keeping boiler pressure on the pump inlet, condensate can be handled at temperatures up to 300 degrees without flashing or vapor binding, whereas the average pump is limited to temperatures below 180 degrees. This has meant efficiency gains of 10 to 15% in many installations.

## A big cut in pump maintenance

Obviously a simple, trouble-free low-pressure centrifugal eliminates the trouble and expense of maintaining steam pumps or multi-stage centrifugals—still another saving. Here is a unit that can make money for you. Let us show you its remarkable record.

The Johnson Corporation

865 WOOD STREET, THREE RIVERS, MICH.


and dissolved oxygen is the controlling factor in causing rust. As the supply of oxygen is definitely limited in a closed heating system, it is evident that the rusting process will be arrested as soon as all available oxygen in the water is used up. Thus sludge formation, from both causes, will stop as soon as the water has been deactiviated on both counts. On the other hand, if the system is periodically drained and refilled, or if there are leaks requiring fresh water makeup, the formation of sludge will start over every time. The amount of sludge formed depends on the original character of the water, on the temperature, and on the size of the system.

*Old Bridge, N. J.* A J LUBELY

## WHY THIS RULE?

### *SETTING SAFETY VALVES*

Adjustment of a safety-valve spring is an item of extreme importance, and many municipalities have laws covering it, including the ASME Power Boiler Code, but some have individual laws in addition to the Code rules. Safety-valve adjustment is prohibited in certain territories except by a licensed engineer. In at least one case, the law requires the adjusting medium of certain safety valves to be locked and the key kept by authorized boiler inspectors who must witness any change of adjustment.

No one should be permitted to tamper with a safety valve, and no one except a qualified engineer should be allowed to change the adjustment. It would be well to check on the laws of the individual locality to see if any supersede the Code rule.

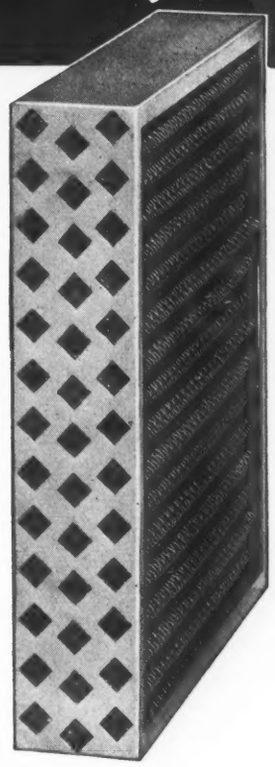
The purpose of restricting the increase of adjustment for popping pressure becomes plain if one considers a spring made up of $\frac{3}{4}$-in. square stock and used for a safety valve having a high lift. Supposing this spring is adjusted for a considerably higher pressure than that for which is was designed, then the clearance between the individual spring coils under this adjustment but with the valve seated would be perhaps one-half of the designed clearance. In such a case, jamming of the spring coils is likely when the safety valve pops, and the valve lift will be restricted. This is a dangerous condition.

Turning to the converse rule, the reduction of a spring setting beyond that specified is a frequent cause of erratic safety-valve performance. Under such conditions the valve may pop at a wide variation of pressures on the same adjustment. This may be hazardous; hence the rule.

As the name plate attached to the safety valve is the most satisfactory method of permanently identifying the various important data on style, type, and adjustments, it is only logical that the rule include the maintenance and correction of this plate. In this manner, the plant owner is protected against possible errors or damage in adjustments by inexperienced men; and the manufacturer is protected by maintaining his nameplate as a true record of the valve limitations.

# 5 Reasons Why

# AIR-MAZE PANELS ARE PREFERRED!



**Because of their superior performance, longer life and greater economy, the trend today is more and more definitely toward the use of permanent air filter panels for air conditioning. Leading in this decided preference are AIR-MAZE panels because in exhaustive tests—both in the laboratory and in actual use—they have proved TROUBLE-FREE. Here are five of the most important reasons:**

## 99.3%—99.83% EFFICIENT

**In its patented construction AIR-MAZE employs an unique application of the baffle-impingement principle which thoroughly filters the air and delivers it 99.3 per cent to 99.83 per cent free of all dust, lint, grit and pollen without restricting full air flow.**

## EASILY CLEANED—CHARGED

**AIR-MAZE Panels will function efficiently two or three times longer than ordinary panels before requiring attention. They are easily cleaned and charged in a few minutes, after which they are like new. Operations are simple and inexpensive, requiring no special equipment or materials.**

## NON-CLOGGING

**The arrangement of graduated mesh screens is scientifically designed to prevent clogging. The dust is deposited uniformly over the whole surface of the panel without any restricted areas. Consequently the free flow of air is unobstructed.**

## NO REPLACEMENTS REQUIRED

**As AIR-MAZE Panels are built to last as long as the air conditioning systems in which they are used, no replacements are required.**

## LONG, ECONOMICAL SERVICE

**Throughout the life of the equipment AIR-MAZE continues to give the satisfactory service which insures maximum efficiency and operating economy of the whole air conditioning unit. With the exception of negligible maintenance expense the first cost is the only cost.**

AIR-MAZE Panels can be furnished in any reasonable size and shape. To assist you in solving your air filter installation problems, write for Bulletin PPS-38. It's FREE!

*There is also an*
**AIR-MAZE AIR FILTER**
*for every*
**INDUSTRIAL APPLICATION**
*Write for complete catalog*

**AIR-MAZE CORPORATION • 5120 HARVARD AVENUE • CLEVELAND, OHIO**

# AIR-MAZE

**PERMANENT CLEANABLE AIR FILTER PANELS**

# a NEW Elgin CONTINUOUS BLOWDOWN [Heat Exchanger] SYSTEM

## —for cleaner, drier steam without heat loss

MORE than any other organization in the field of boiler water conditioning, Elgin has recognized the troubles caused by concentration in boiler water and has devoted years of study and research to the means of reducing this primary cause of priming, foaming and wet steam.

In developing the "Deconcentrator", Elgin solved the problem of removing the sludge and mud in plants where the water supplies are primarily sludge-producing. And now for those plants where the problem is reduction of soluble concentrations, important advances have been made in the Elgin Continuous Blow down-Heat Exchanger System.

This new Elgin System offers a dependable means for accurately controlling and regulating the amount of concentration, combined with an efficient means of reclaiming the heat that is lost by ordinary methods. It accomplishes results in a simple, direct way—eliminates the awkward weirs, orifices, float boxes and other complications of so-called "automatic" systems; yet it holds the concentration within a close and satisfactory range, and effects a real gain in thermal efficiency.

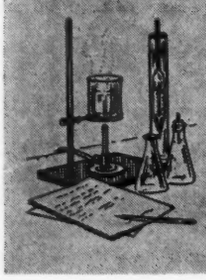
The old hit-or-miss method of blowing down boilers is obviously out of place in an age of efficiency. Former systems of continuous blowdown have made big strides in eliminating this waste, but it remained for the highly developed Elgin System to set a still higher standard of efficiency and economy.

Since Elgin methods and equipment embrace all modern, approved practices in boiler water conditioning, we are in a position to give you unbiased recommendations covering your particular problems. Elgin individualized boiler water treatment service, along with Elgin laboratory and plant control service, is given without charge to Elgin users.

*Write for latest bulletins*

**ELGIN SOFTENER CORPORATION, 55 North Street, Elgin, Illinois**

**ELGIN Equipment and Service blankets all requirements**



● Elgin boiler water treating methods cover both water softeners and individualized internal treatments which are recommended in accordance with individual plant requirements. Elgin concentration control equipment covers both the Elgin Deconcentrator (for sludge removal) and the continuous blowdownheat exchanger system described here (for control of soluble concentrations). Elgin laboratory and plant control service—the most thorough ever organized—is given without charge to Elgin Users. Other Elgin equipment includes chemical feeders, pressure sand filters, aerators, oil removal filters, corrosion control systems, water testing equipment, and similar equipment. Write for bulletins covering the phase of water conditioning in which you are interested.

**ELGIN** *Makes boilers* **SELF-CLEANING**


## Europe Turns to Gas Producers

(*Continued from page* 92)

knock and results in backfiring. Another cause of backfiring is unsuitable spark plugs. Producer gas requires a more intense spark than does gasoline; the best gap is between 0.012 and 0.018 in. Delayed starting may be due to excessive moisture in the fuel, irregular distribution of the fire zone, or too much ash in the producer. Leaky flanges and joints will increase fuel consumption; the defective spots can be found by burning some intensely smoking substance in the producer, with outlets closed.

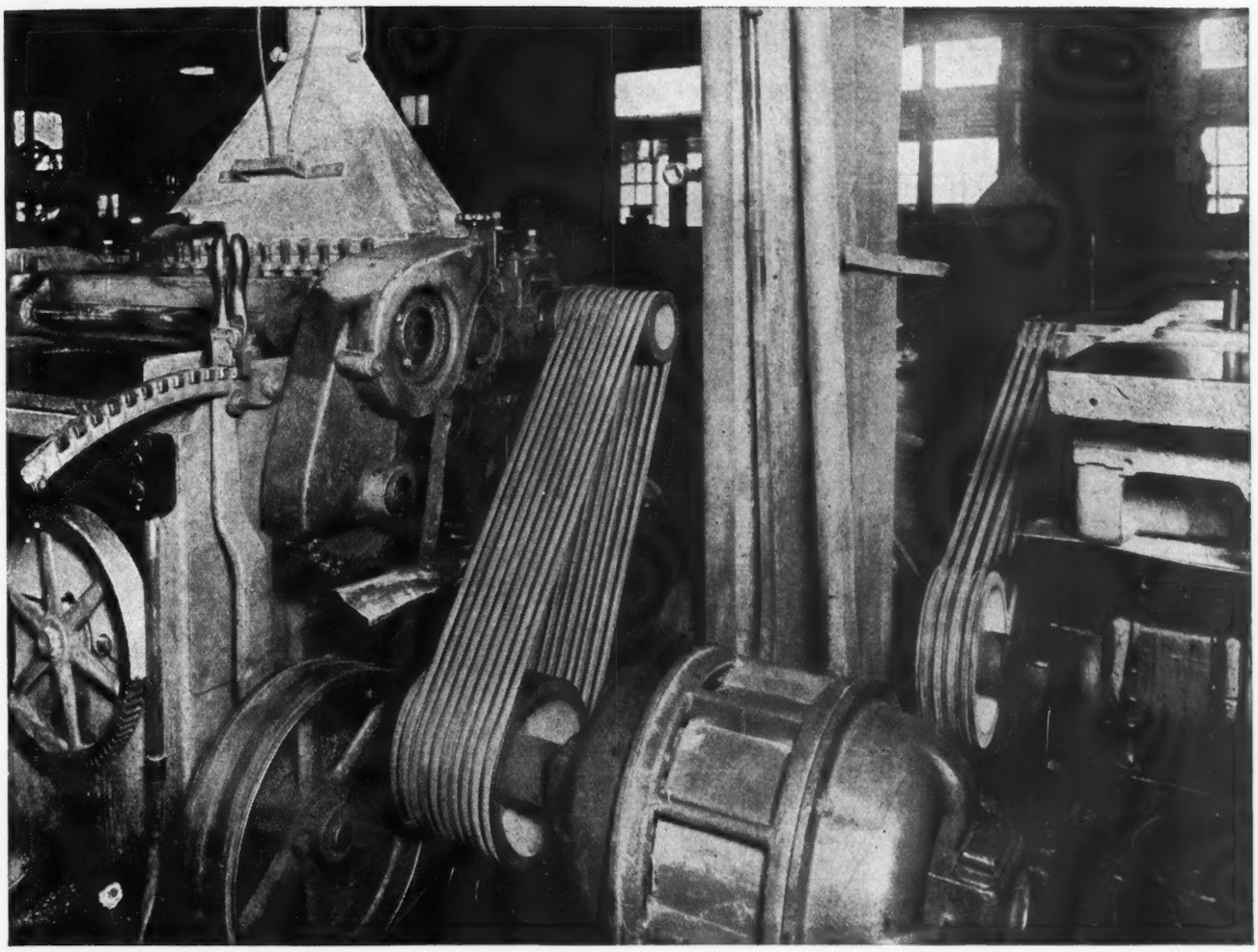
Disadvantages of producer plants are additional work and loss of time in starting, higher upkeep, and a limited radius of operation (for transportation units). As definite temperature ranges within the reaction zone must be respected, engine speed at no-load and partial loads will be higher than with gasoline. The lower limit for rational producer operation is at about ¼ of rated capacity, which explains why a producer-equipped unit is more delicate to handle than a gasoline unit.

European makers consider portable producers to be a product for domestic use which offers advantages as insurance against unfavorable circumstances, where liquid fuel supplies might be restricted to such an extent that domestic fuels must be resorted to for motor vehicles. In Central Europe a network of solid-fuel supply stations at intervals of about 25 miles is being organized, while some producer-equipped cars can cover more than 100 miles without refueling.

Still, the number of producer-equipped transportation units is hardly over 10,000 in all Europe. Running a producer plant requires extra labor and superior ability, willingness, and intelligence on the part of the operators. Cleaning the system is unpleasant on account of soot and dirt, but must be done fairly often. A producer plant takes more space and weight than a gasoline plant of the same power, so the useful load is reduced. First cost, naturally, is higher with producer-equipped plant.

In regard to fuel prices, a gallon of gasoline will cost about $.50 to $.60 in most European countries, while air-dried producer wood will cost anything between $.10 and $.60 per 100 lb, with 20-22 lb of wood equivalent to 1 gal. of gasoline. The charcoal equivalent is 9-11 lb, and the cost of charcoal is about three times that of wood. The consumption figures in Table I should be increased by about 10% for starting.

Recently the field for portable producers has been narrowed by the development of synthetic gasoline, and by the progress made in the utilization of bottled gases such as butane, propane, or compressed town gas. Moreover, in most districts, wood reserves could hardly meet all the fuel demand. Certain fields of application will remain open, however, especially where wood refuse must be disposed of economically.



# NOW—matched sets of GOODRICH V-BELTS deliver more power, last longer, save you money

NOW, for the first time, you can buy a set of V-belts and know they will all carry the load evenly—and so deliver more power, wear evenly and therefore last longer.

In almost every set of V-belts, of any make, there have been up to now one or two enough longer than the others to idle on the drive and let the balance carry the load while the longer belts slipped, wore out quickly, ruined the set. Belts might measure the same off the drive but under working tension the difference in length showed up—too late to be corrected.

Goodrich engineers, who made the first successful V-belts and have had the most experience in their development, have now invented a machine which measures belts *under operating tension.* Length is stamped on each belt, and sets are made up only of those belts which will operate together as a perfect team, as V-belts should.

This is only one of the important advantages you get when you specify Goodrich V-Belts. Goodrich is the true V-belt—made with straight-edge construction so it operates by *side pressure.* Goodrich V-Belts will not slip.

They are made with a special Goodrich Cord which assures the maintenance of even tension and delivery of maximum power throughout the long life of the belt.

Goodrich V-Belts are made with Age-Rite—a special Goodrich compound which improves ageing qualities as much as 200%. The rubber in Goodrich belts is another important development—it reduces internal heat (which is what wears out other belts prematurely) by 75%.

Put Goodrich V-Belts on your drives and you will find they deliver more power, reduce bearing and machinery repairs, end shutdowns for belt repairs, and last longer with far less attention and trouble on your part. Goodrich V-Belts are available everywhere. Call your Goodrich Distributor now—and save money. The B. F. Goodrich Company, Mechanical Rubber Goods Division, Akron, Ohio.

**Goodrich**

ALL *products problems* IN RUBBER

"Call in.. 'The SCAIFE MAN'

HE KNOWS WATER TREATMENT . . .

—AND IT'S DOLLARS TO DOUGHNUTS HE CAN HELP SOLVE OUR BOILER FEED WATER PROBLEMS"

A safe wager, Gentlemen! THE SCAIFE MAN *can* help you unravel the costly tangle that develops in power plant operation when boiler feed water is at fault. His specialized knowledge is broad-based on experience with every type of plant—all conditions of water—and sound methods of treatment well-proved in practice.

Count THE SCAIFE MAN *in* on your next discussion . . . and you'll have at your elbow the feed water lore of a long-leading organization in the field of water treatment—entirely without obligation. We cordially invite you to make use of this service at any time!

Scaife MANUFACTURES FOR THE POWER INDUSTRY: Water Softeners: Hot Lime Soda . . . Cold Lime Soda . . . Sodium Zeolite . . Hydrogen Zeolite. Water Filters: Gravity . . . Pressure. Continuous Blowdowns; Zeolite Minerals; Filter Refills.

*Let us quote you!*

WM. B. SCAIFE & SONS CO.

General Office, Laboratory and Works—OAKMONT, PA.
(Pittsburgh District)
Branch Offices in Principal Cities

## STRAWS

(*Continued from page* 100)

trator, 135 N Broadway, plans central-heating plants in four large housing projects, on which work will begin soon.

Board of County Supervisors, San Diego, plans central heating plant in new multi-story Hall of Justice, for which a fund of $1,250,000 is being arranged. Proposed to begin work in spring. Engineering department in charge.

State Board of Education, Sacramento, plans central-heating plant at new multi-unit State Teachers' College at Santa Barbara. $1,300,000 being arranged for project. State Dept of Architecture, Sacramento, architect.

Imperial Irrigation District, El Centro, has low bid from Nordberg Mfg Co, at $449,137 for two diesel generator units and auxiliary equipment for installation in power plant at Brawley, and will make award soon. M J Dowd, Imperial, chief engineer.

**COLORADO**——Colorado Springs will begin work soon on improvements in municipal hydroelectric plant, including 2000-kw hydraulic turbine and auxiliary equipment. Cost about $470,000.

Dept of Public Buildings, Denver, contracted Dutton, Kendall & Hunt, Inc, Denver, for erection of state capitol power house and shop. Cost about $300,000, with equipment, for which awards will be made separately. Gordon D White, 615 Columbine St, architect.

Bureau of Reclamation, Denver, contracted Newport News Ship-building & Dry Dock Co, Newport News, Va., for three 11,500-hp hydraulic turbines at $128,470, for installation in Elephant Butte hydroelectric power plant, and at $97,790 for two similar units for Green Mountain hydroelectric plant, near Kremling. Also made award to Woodward Governor Co, Rockford, Ill., for three governor units for turbines at Elephant Butte station, at $35,919, and for two governors for turbines at Green Mountain plant, at $23,946. Awards for other equipment for plants noted will be made soon.

**CONNECTICUT**——State Dept of Public Works, State Office Bldg, Hartford, contracted S C Poriss & Co, Hartford, at $205,912 for central-heating plant and system for Connecticut State College, Storrs.

Autoyre Mfg Co, Oakville, plans one-story addition to wire goods-manufacturing plant, 60 x 200 ft. An air-conditioning system will be installed, in addition to power equipment, traveling cranes and other mechanical-handling equipment. A new boiler house, 40 x 60 ft., also will be built. Cost reported close to $100,000, with equipment. Fletcher-Thompson, Inc, 1336 Fairfield Ave, Bridgeport, architect and engineer.

**FLORIDA**——Lakeland contracted Allis-Chalmers Mfg Co at $110,000 for turbine-generator and accessories for municipal electric plant. Also made award to Wheeler Mfg Co at $36,000 for condenser and auxiliary equipment; and to J B McCrary Engrg Co, Atlanta, Ga., for erection of plant addition. Awards for other equipment will be made soon.

**GEORGIA**——National Battery Co., 2315 Pine St., St. Louis, Mo., plans 1-story plant on Taylor Ave, East Point district, Atlanta. Cost about $200,000, including machinery and power equipment. Work scheduled to begin soon.

**ILLINOIS**——Montgomery Ward & Co, Chicago, plans central-heating plant in new 3-story and basement department store at Plattsburg, N. Y. Bids will be asked soon.

Board of Public Works, Rock Island, plans call for bids this month for Rock River pumping station and force main for new sewerage disposal plant and system, estimated cost $150,000; also, in May, bids will be asked for pumping stations and part of sanitary sewer system, to cost about $476,000. Entire project will cost approximately $3,000,000. Consoer, Townsend & Quinlan, Inc, 205 West Wacker Dr, Chicago, consulting engineer.

Board of Education, 228 N LaSalle St, Chicago, plans central-heating plant in new vocational and trade school at Chicago. Cost about $3,500,000. John C Christensen, address noted, architect.

Bushnell will make awards soon for equipment for new municipal electric plant. Cost about $200,000. Warren & Van Praag, Inc, Milliken Bldg, Decatur, consulting engineer.

**INDIANA**——Dept of Public Works, Fort Wayne, plans extensions in municipal electric plant, with installation of boiler unit and auxiliary equipment.

Rushville will award contracts soon for

# Fly Ash Collection Guaranteed

## With No Strings Attached

**Get the answers to these questions before you invest in Dust Collection Equipment:**

| Questions | Answers by Cottrells |
|---|---|
| **1.** What percentage of ***total*** solids, irrespective of particle size or nature, is the equipment guaranteed to collect? | **1.** Cottrell Electric Precipitators can be guaranteed to collect up to 99.99% of the ***total*** solids entering the equipment. |
| **2.** What will it cost to operate? | **2.** Cost of electrical power ranges from .5 to 1.0 K.W.H. per 100,000 cu. ft. of gas cleaned. |
| **3.** What will it cost to maintain? | **3.** With no wearing parts, maintenance cost is negligible. |
| **4.** What will the pressure drop be? | **4.** Pressure drop is only a few tenths of an inch of water. |
| **5.** How long will it last with sustained performance? | **5.** Cottrells installed 25 years ago are still operating at full efficiency. |

We are prepared to make authoritative smoke or dust determinations and to design and install the correct equipment for dust, fog, fume and mist control for any industry — mines, power plants, iron blast furnaces, electric furnaces, paper mills, cement mills, acid plants, oil refineries, gas plants, and chemical industries.

With a complete range of dust collecting and gas cleaning equipment we will give an unconditional guaranty of efficiency to **any** desired percentage of the ***total*** solids entering the collector, irrespective of particle size or nature. Collection may be wet or dry, and at any temperature from atmospheric to 1200° F.

*Typical Fly Ash Cottrell*

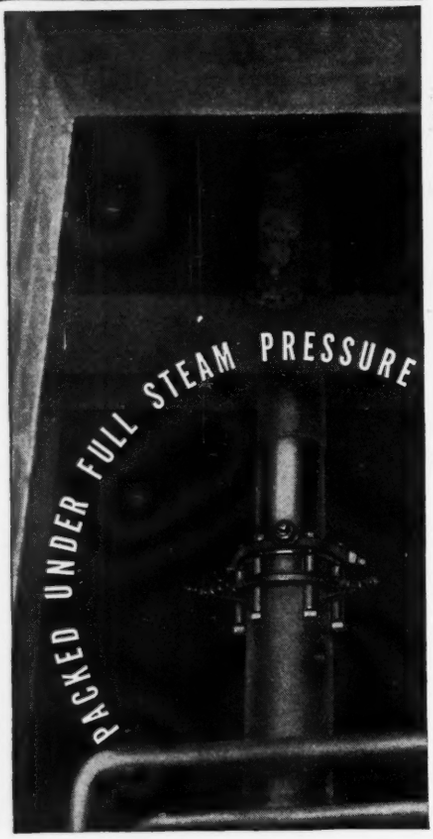
**Send for Bulletins**

**WESTERN PRECIPITATION CORPORATION**
1016 W 9th ST., LOS ANGELES, CALIF

**RESEARCH CORPORATION**
405 LEXINGTON AVENUE
NEW YORK CITY, N. Y.

**PIONEERS IN DUST AND FUME CONTROL**

YARWAY
GUN-PAKT
EXPANSION
JOINTS




**Here is the RECORD at Large Southern Utility**

First purchased Yarway Expansion Joints 7 years ago. Reordered 16 times to present total of 41 joints.

*Service:* 150 lbs. pressure, 75° to 100° superheat.

*Maintenance Report:* Never removed all old packing from any joint. Very economical of packing, time and attention. Gun-Pakt Joints repacked at will under full operating pressure by the simple twist of a wrench.

Write for catalog EJ-1906 describing the many time, labor and money saving features of Yarway Expansion Joints.

YARNALL-WARING CO.
100 Mermaid Ave., Phila., Pa.

equipment for extensions in municipal power plant, including 4-drum watertube boiler of 4500-sq-ft heating surface, circulating and condensate pumps, superheater, traveling-chain-grate stoker, soot blower, combustion-control equipment, etc. Bevington-Williams, Inc, Indiana Pythian Bldg, Indianapolis, consulting engineer.

Troy Refining Co, Troy, plans power house at proposed new oil-refining plant in vicinity of Barker Ave, Evansville. Cost over $125,000. Dewey Stinson, general manager.

Corydon plans early purchase of boiler unit and accessories, three pumping units with capacities of 80, 20 and 15 gals. per min., respectively, gas-control equipment, tanks and other equipment for new municipal sewerage treatment works. Cost over $100,000. Lennox & Matthews, Architects' and Builders' Bldg, Indianapolis, consulting engineers.

Pitman-Moore Co, Inc, 1220 Madison Ave, Indianapolis, plans 5-story and basement addition, 60 x 136 ft., to drug and pharmaceutical plant. Cost about $300,000 with equipment, including power apparatus. Robert F Daggett, 445 N Pennsylvania St, architect.

**IOWA**——Glidden contracted Fairbanks, Morse & Co for diesel-generator unit and auxiliary equipment for municipal electric plant, at $37,500. C M Stanley, Muscatine, consulting engineer.

New Hampton plans expansion in municipal electric plant, including 750-kw diesel-generator unit and auxiliary equipment. J W Wittenburg, city engineer.

Dayton contracted Fairbanks, Morse & Co for engine-generator unit and auxiliary equipment for new municipal power plant. Cost about $50,000. R W Gearhart, 349 21st St, S.E., Cedar Rapids, consulting engineer.

Lamoni contracted Fairbanks, Morse & Co, at $32,176 for two 300-hp diesel-generator units and accessory equipment for municipal electric plant. Also made award to Barr-Thorp Co, Kansas City, Mo., for switchboard and instruments. Other contracts will be let soon. New station will cost about $85,600. Young & Stanley, Inc, Muscatine, consulting engineer.

Cascade contracted Fairbanks, Morse & Co at $36,750 for diesel-generating unit and accessories for municipal power plant. Also made award to Electric Machinery Mfg Co for switchboard and instruments; and to A K Keep Co, Rochester, Minn., at $15,149 for erection of building. Other contracts will be placed soon. New station will cost about $110,000. Young & Stanley, Inc, Muscatine, consulting engineer.

State Board of Control, Des Moines, is considering new steam power plant at institution at Marshalltown. Cost about $150,000, with equipment.

Anita plans municipal light and power plant to cost about $170,000. Young & Stanley, Inc, Muscatine, engineers.

**KANSAS**——Hillsboro will award contracts soon for pipeline system for municipal natural-gas distribution, including main welded-steel pipeline for connection with source of supply, control station and other operating facilities. Cost about $50,000. Hefling & Hunter, East Second St, Hutchinson, consulting engineers.

Winfield contracted Allis-Chalmers Mfg Co for turbine-generator exciter and condenser, with auxiliary equipment, for municipal electric plant. Entire project will cost about $177,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

Board of Public Utilities, City Hall, Kansas City, plans extensions in Quindaro pumping station for municipal water system, including new pumping machinery, steam or electric-driven, with gross capacity of 25,000,000 gpd, and other equipment. Cost close to $500,000. Burns & McDonnell Engrg Co, 107 W Linwood Blvd, Kansas City, Mo., consulting engineer.

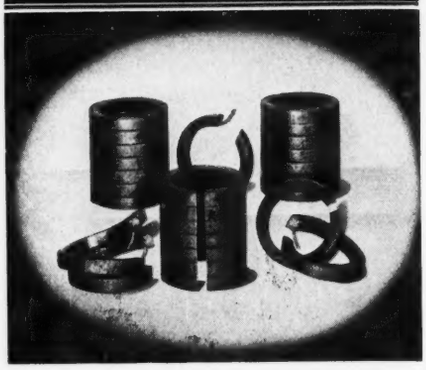
Randolph is considering municipal light and power plant, which will probably come to the fore again about the time of the municipal elections in April. In the meantime, however, the project is dormant but not dead, according to city officials. Paulette & Wilson of Salina and Topeka are consulting engineers.

**KENTUCKY**——Burkesville plans taking bids at an early date on construction of municipal light, heat and power plant, for which $65,000 in bonds were voted several weeks ago. J L Watkins, Lexington, consulting engineer.

**LOUISIANA**——Kentwood Ice Mfg Co, Kentwood, plans 1-story ice-manufacturing plant. Cost about $35,000, with equipment. Work scheduled to begin soon. William J Day, head.

Lincoln Creosoting Co, Benton Rd,

*Do You Nurse Your Packing?*



SEA-RO NEK-SEAL* Packing Rings are designed to take care of themselves under all kinds of difficult operating conditions. Installation is remarkably simple and quick. No cutting to size—no careful fitting—no waste—engineered to *your* specifications.

• Operation requires a minimum of attention. The patented Nek-Seal* fillet forms a permanent anti-frictional seal of neck bushing clearances, eliminating leakage, blow-by and loss of pressure. This packing needs no babying or fussing with to deliver dependable, day-in, day-out performance. Keeping high pressure equipment packed is no longer a problem when you use Nek-Seal*.

• Why not investigate today just what Nek-Seal* can do in cutting *your* packing costs and maintenance. An inquiry will bring you complete information without obligation.

*Reg. U. S. Pat. Off.

**Sea-Ro Packing Company**
**75 West Street, New York, N.Y.**

SEA-RO

GLOBE Seamless TUBES

# *Safety* THAT MEASURES UP TO MODERN PRESSURE AND TEMPERATURE DEMANDS

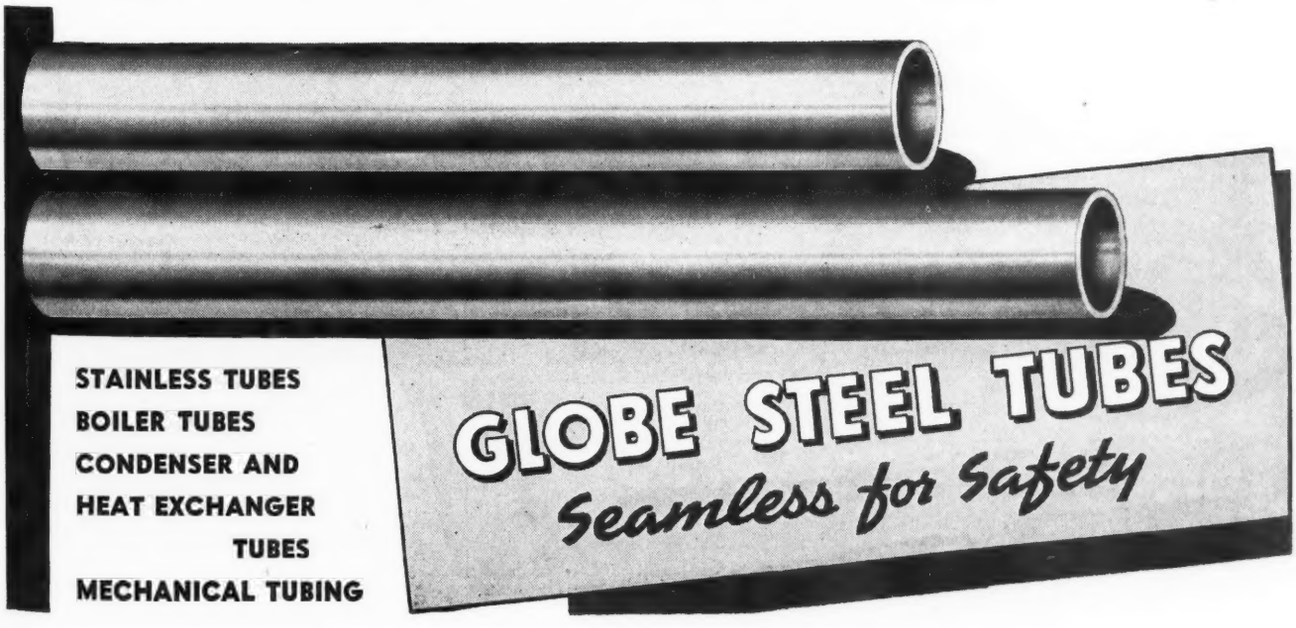
Service records in many of the nation's noteworthy power plants — their use by leading railroads, industrial and marine boiler builders — attest the greater value, safety and savings of Globe Seamless Steel Tubes.

The extra margin of safety and strength — particularly vital to meet modern high pressure and temperature demands — more than offsets any immediate advantage of lower first cost.

Globe engineers are always available to assist in selecting a tube with the exact characteristics you require.

Check with a Globe engineer before you specify boiler tubing.

**GLOBE STEEL TUBES CO. • 4050 W. Burnham St., *Milwaukee, Wis.***




STAINLESS TUBES
BOILER TUBES
CONDENSER AND HEAT EXCHANGER TUBES
MECHANICAL TUBING

# When nuts work loose . . . anything can happen and often does!

## Protect your equipment with

UNSHAKO

The Nuts that can't shake loose

Fig. 1513

Pat'd and Pat's Pending.

It's always hazardous for nuts to work loose. The effect may mean injury to some workman or damage to your equipment. Play safe. Put "Unshako" Self-Locking Nuts every place where other nuts fail to hold . . . and, especially, be sure to use them when installing diesels, reciprocating engines, pumps, conveyors, generators, stokers, as well as many other types of equipment. They provide "live action" that grasps the bolt or stud whenever there's a backing-off tendency and thereby insure permanent tightness. Of course, they can be removed with a wrench and re-used if desired. Write for complete details.

**STANDARD PRESSED STEEL Co**

BRANCHES: BOSTON, DETROIT, INDIANAPOLIS

JENKINTOWN, PENNA.

Box 577

BRANCHES: CHICAGO, ST. LOUIS, SAN FRANCISCO

# Buffalo prefers

TRADE FRICK MARK

And proves it with over 1000 installations—for air conditioning, food service, cooling drinking water, making ice, cold storage, industrial processes, and dozens of other purposes. All credited to Mollenberg-Betz Machine Co., Frick Sales Representatives. Get figures now on that cooling equipment you need, large or small, write:

**FRICK COMPANY**

Waynesboro, Penna.

# Refrigeration


Shreveport, plans creosoting plant on site near Heber Springs, Ark., for pole and timber treatment, to include power house and pumping station. Cost close to $100,000. C A Tooke, vice-president.

Lafayette will award contract soon for extensions in municipal electric plant, including 1000-kw diesel-generator unit and accessory equipment. V E Smith, city engineer.

Godchaux Sugars, Inc, Masonic Temple Bldg, New Orleans, plans addition to cane-sugar mill at Raceland. Work scheduled to begin soon. Cost about $100,000 with machinery and power equipment. George P Rice, Baronne Bldg, New Orleans, consulting engineer.

Todd-Johnson Dry Docks, Inc, New Orleans, plans boiler plant at dry docks and shipyard on West bank of Mississippi River, opposite New Orleans, to replace unit recently destroyed by fire. Also will rebuild other sections of plant destroyed, with installation of new equipment. Loss over $200,000, including machinery.

Iberia Parish Police Jury, New Iberia, plans central-heating plant in new 3-story courthouse. Work will begin early in spring. Cost about $200,000. N W Overstreet and A H Town, 535 Jefferson St, Lafayette, architects.

**MICHIGAN**——Gelatin Products Co, 620 E Hancock St, Detroit, plans new 2-story plant on Grinnell Ave. Cost over $100,000, with general machinery, power equipment, etc. Smith, Hinchman & Grylls, Inc, Marquette Bldg, architect and engineer.

Hoskin Paper Co, Menominee, contracted Allis-Chalmers Mfg Co for pumping machinery and auxiliary equipment for new filter plant at paper mill. L A DeGuere, Wisconsin Rapids, Wis., consulting engineer.

Hygrade Food Products Corp, 2801 Michigan Ave, Detroit, contracted Krieghoff Co, 6661 French Rd, for addition to steam power house at plant, with installation of boiler units and auxiliary equipment. Cost over $35,000.

Holland let contract to Lake States Engrg Co, 111 W Jackson Blvd, Chicago, Ill., at $97,353 for building erection for new municipal electric plant. Equipment awards are being made separately. Entire project will cost about $1,500,000.

State Dept of Buildings, Lansing, contracted J A Utley Co, 6031 Mansur St, Detroit, at $72,900 for new power house at Coldwater, exclusive of equipment, for which awards will be made separately.

Clinton contracted North-Moller Co, Jackson, at $23,520 for extensions in municipal electric plant. Awards for equipment will be made separately. Fund of $121,000 has been arranged for entire project. Fargo Engrg Co, Jackson, consulting engineer.

**MINNESOTA**——Cambridge is considering municipal electric plant to cost about $200,000, with equipment. Proposed to begin work in spring. Ralph D Thomas Associates, Inc, 1200 Second Ave South, Minneapolis, consulting engineer.

Preston contracted Fairbanks, Morse & Co for diesel-generator unit and auxiliary equipment, with cooling tower, etc, for municipal electric plant, at about $46,300. G M Orr & Co, Baker Arcade Bldg, Minneapolis, consulting engineers.

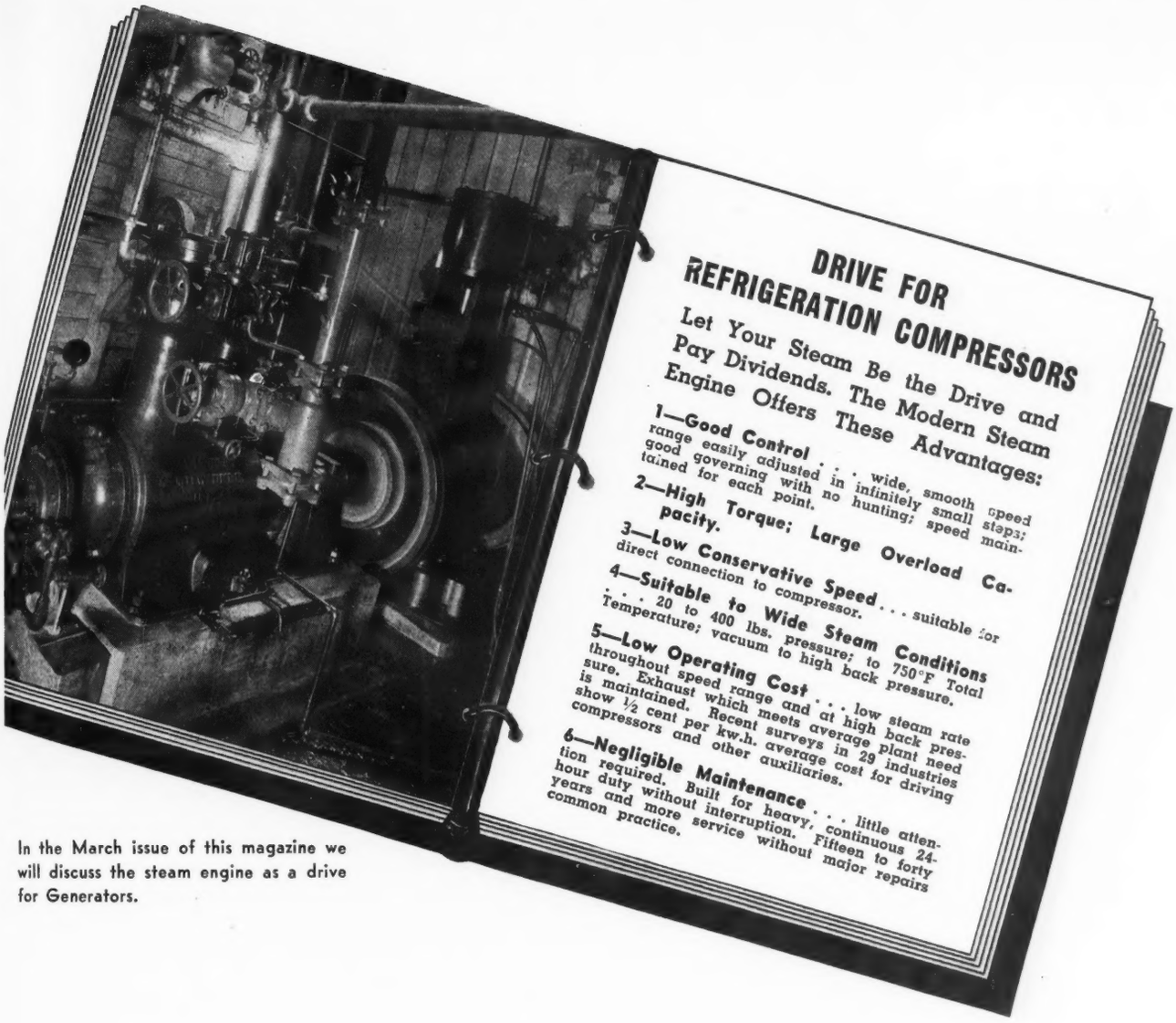
Alexandria contracted Power Service Corp, Wesley Tower Bldg, Minneapolis, for extensions in municipal steam power plant, used for central heating service, at about $132,400, including installation of new boiler unit and accessories, coal and ash-handling equipment, piping, combustion-control apparatus, etc. Burlingame, Hitchcock & Estabrook, Inc, Sexton Bldg, Minneapolis, consulting engineer.

Delano plans improvements in municipal electric plant, including new boiler unit and other equipment. Bids will be asked soon. G M Orr & Co, Baker Arcade Bldg, Minneapolis, consulting engineers.

Melrose plans early call for new bids for extensions in municipal electric station, including diesel-generator unit, to replace present steam engine, and complete auxiliary equipment. Cost about $53,000. Bids recently received have been rejected. Ellerbe & Co, First National Bank Bldg, St. Paul, consulting engineers.

Springfield plans early call for bids for equipment for improvements in municipal electric plant, including 1000-kw turbine-generator with accessories, 4000-sq-ft boiler and auxiliary equipment. Cost about $150,000. Charles Foster, Medical Arts Bldg, Duluth, consulting engineer.

**MISSOURI**——State Building Commission, Merchants' Bank Bldg, Jefferson City, Edgar M Eagan, executive secretary, Bi-Partisan Advisory Board, will receive bids until Feb. 7 for boiler instruments and combustion-control equipment for


DRIVE FOR
REFRIGERATION COMPRESSORS
Let Your Steam Be the Drive and Pay Dividends. The Modern Steam Engine Offers These Advantages:
1—Good Control . . . wide, smooth speed range easily adjusted in infinitely small steps; good governing with no hunting; speed maintained for each point.
2—High Torque; Large Overload Capacity.
3—Low Conservative Speed . . . suitable for direct connection to compressor.
4—Suitable to Wide Steam Conditions . . . 20 to 400 lbs. pressure; to 750°F Total Temperature; vacuum to high back pressure.
5—Low Operating Cost . . . low steam rate throughout speed range and at high back pressure. Exhaust which meets average plant need is maintained. Recent surveys in 29 industries show ½ cent per kw.h. average cost for driving compressors and other auxiliaries.
6—Negligible Maintenance . . . little attention required. Built for heavy, continuous 24-hour duty without interruption. Fifteen to forty years and more service without major repairs common practice.

In the March issue of this magazine we will discuss the steam engine as a drive for Generators.

Nearly one-third of Troy-Engberg Steam Engines sold during 1938 were for driving refrigeration compressors, marine as well as land installations claiming their share. Listed above are several fundamental reasons *why* the modern steam engine is so suitable for this kind of work and *why* it deserves this popularity.

But there are plenty of other places where plant operators could start out with a better drive and with more economy by specifying a steam engine drive for new equipment, or where they could improve operations and costs by changing over. Stokers, pumps, fans, blowers, generators, air compressors . . . these, too, operate well and at low cost with engine drives.

We have catalogues and bulletins giving full details as to use, design, advantages and economy of the Troy-Engberg Steam Engine. Shall we send you copies?

LET YOUR STEAM PAY DIVIDENDS

**TROY ENGINE AND MACHINE CO.**

**ESTABLISHED 1870**

**1445 Railroad Avenue, Troy, Pa.**

# HOTEL ENGINEER SAVED $3600 BY "MEGGER" TESTING

CHALFONTE-HADDON HALL
Atlantic City, N. J.

**POWER failure and "lights out" are simply unthinkable in a hotel as fine and popular as Atlantic City's *Chalfonte-Haddon Hall.* The Chief Engineer avoids trouble and protects the hotel and its guests by periodic insulation resistance tests with a "Megger" Insulation Testing Instrument. He tests "everything"—generators, cables, motors, elevator equipment and wiring.**

**One day, for example, a routine test disclosed—quite unexpectedly — an incipient weakness in the insulation of the cables leading to one of the 500-kw generators. A short circuit was thereby forestalled and saved (1) a minimum of $3600, including repairs to the machine and 2000 feet of cable, and (2) an embarrassing and costly shutdown.**

**The Management of Chalfonte-Haddon Hall knows how little it costs to do an *efficient* electrical maintenance job based on "Megger" testing,—that there is simply no comparison between the "Megger" *preventive maintenance* plan and the old chase-trouble - after - it - happens method.**

***If you ought to be making "Megger" tests, write today for our informative "Megger" Catalog 1550-P***

**JAMES G. BIDDLE CO.**

ELECTRICAL INSTRUMENTS

1211-13 ARCH STREET PHILADELPHIA, PA.


power plants at institutions at Jefferson City, Fulton, Farmington, Mount Vernon and Marshall. Charles A Haskins, Finance Bldg, Kansas City, Mo., consulting engineer.

Palmyra contracted McIntosh & Seymour Corp for diesel unit and accessory equipment for municipal power plant, at $50,342. Improvements have been authorized to cost approximately $67,000. Frank Beard, Kahoka, Mo., consulting engineer.

Lathrop will award contract soon for municipal electric plant, including two 150-kw diesel-generator units and auxiliary equipment. Also for electrical distributing lines. Cost about $75,000. E T Archer & Co, New England Bldg, Kansas City, consulting engineer.

Nevada has authorized surveys and estimates of cost for proposed municipal electric plant. Financing will be arranged soon.

Owensville contracted Fairbanks, Morse & Co at $68,500 for diesel-generating units and auxiliary equipment for municipal electric plant. Russell & Axon, 4903 Delmar St, St. Louis, consulting engineers.

Macon plans extensions in municipal electric plant and waterworks station, including additional equipment. Cost about $197,700, of which $110,000 represents a bond issue, recently voted, with remainder secured through Federal aid. Baumes Engrg Co, Railway Exchange Bldg, St. Louis, consulting engineer.

Lamar awarded a contract to Fairbanks, Morse & Co for installation of two 1050-hp diesel-generating sets, etc, at $186,197.

Sikeston—A terrific explosion which shook Sikeston December 14 wrecked a Diesel engine, damaged the building of the municipal light plant and injured Kenneth Williams, night engineer. Charles Moose, superintendent of the plant, said it is possible gas accumulated in the crank case of the engine from some unknown cause and may have been responsible for the explosion. The engine was purchased in 1935 at a cost of $62,187. All windows in the building were shattered and the roof was partly torn off by the blast. Damage to the building is estimated at about $3,000.

**MONTANA**——State Water Conservation Board, Helena, plans large electric-operated pumping station at Great Falls, for water supply from Missouri River for irrigation system of Ulm Irrigation Project. $118,000 has been arranged for plant.

**NEBRASKA**——York plans municipal electric plant, using diesel-generator units and accessories. Cost about $425,000. C Robert Fulton and N Bruce Hazen, 2327 S. 19th St., Lincoln, consulting engineers.

Paxton & Vierling Iron Works, Inc, 17th St, Omaha, plans four 1-story additions, for steel plant, 120 x 160 ft.; machine shop, 40 x 280 ft.; foundry, 70 x 250 ft.; and material building, 80 x 500 ft. Cost over $250,000 with machinery and power equipment. Work scheduled to begin at once.

**NORTH CAROLINA**——Duke Power Co, Charlotte, has approved immediate construction of new steam-electric plant on Broad River, Cliffside, to be equipped for initial capacity of 100,000-hp, with later installation to develop a total of about 320,000-hp. Cost close to $1,000,000. Completion is scheduled early in 1940.

**OHIO**——Wellston will award contracts soon for extensions in municipal electric plant, including additional equipment. Cost about $200,000. F W C Bailey, 20 South Third St., Columbus, consulting engineer.

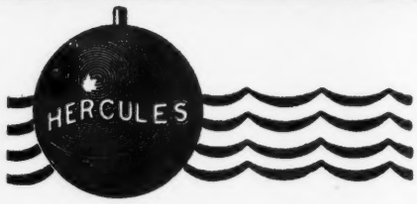
F & R Lazarus Co, High and Town Sts, Columbus, plans central-heating plant in new 6-story retail store and service building. Cost about $750,000. Richards, McCarty & Bulford, 524 E Broad St., architects.

Troy contracted B D Morgan & Co, Middletown, at $23,422 for construction of addition to municipal electric plant, exclusive of equipment, for which various awards will be made soon. Cost about $85,000. Froehlich & Emery Engrg Co, Second National Bank Bldg, Toledo, consulting engineer.

Dept of Public Works, Cincinnati, has low bid from L E Stevens Co, 622 Broadway, at $30,935 for steam-supply piping, stoker, coal-handling machinery and auxiliary equipment for central incinerator plant, and will make award soon. Fosdick & Hilmer, Union Trust Bldg, consulting engineers.

Board of Education, Lorain, plans installation of stoker and auxiliary equipment in power house for school service. W A Pillans, business manager, in charge.


# HERCULES
*Seamless Copper*
# FLOATS




## GUARANTEED TO STAND UP!

**Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.**

**Fabricated of seamless copper under our special spinning process, Hercules Floats are uniform in thickness and high in mechanical strength.**

**You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.**

**Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."**

**HERCULES FLOAT WORKS**
200 Franklin St.
SPRINGFIELD, MASS.

# ELIMINATE COSTLY SHUT DOWNS from Leaking Boiler or Condenser Tubes

with

## MADE-RITE PLUGS

***"the Hit of the Power Show"***

Here, at last, is the practical answer to stopping leaks in condenser and boiler tubes without pulling the fire or losing a minute of operating time.

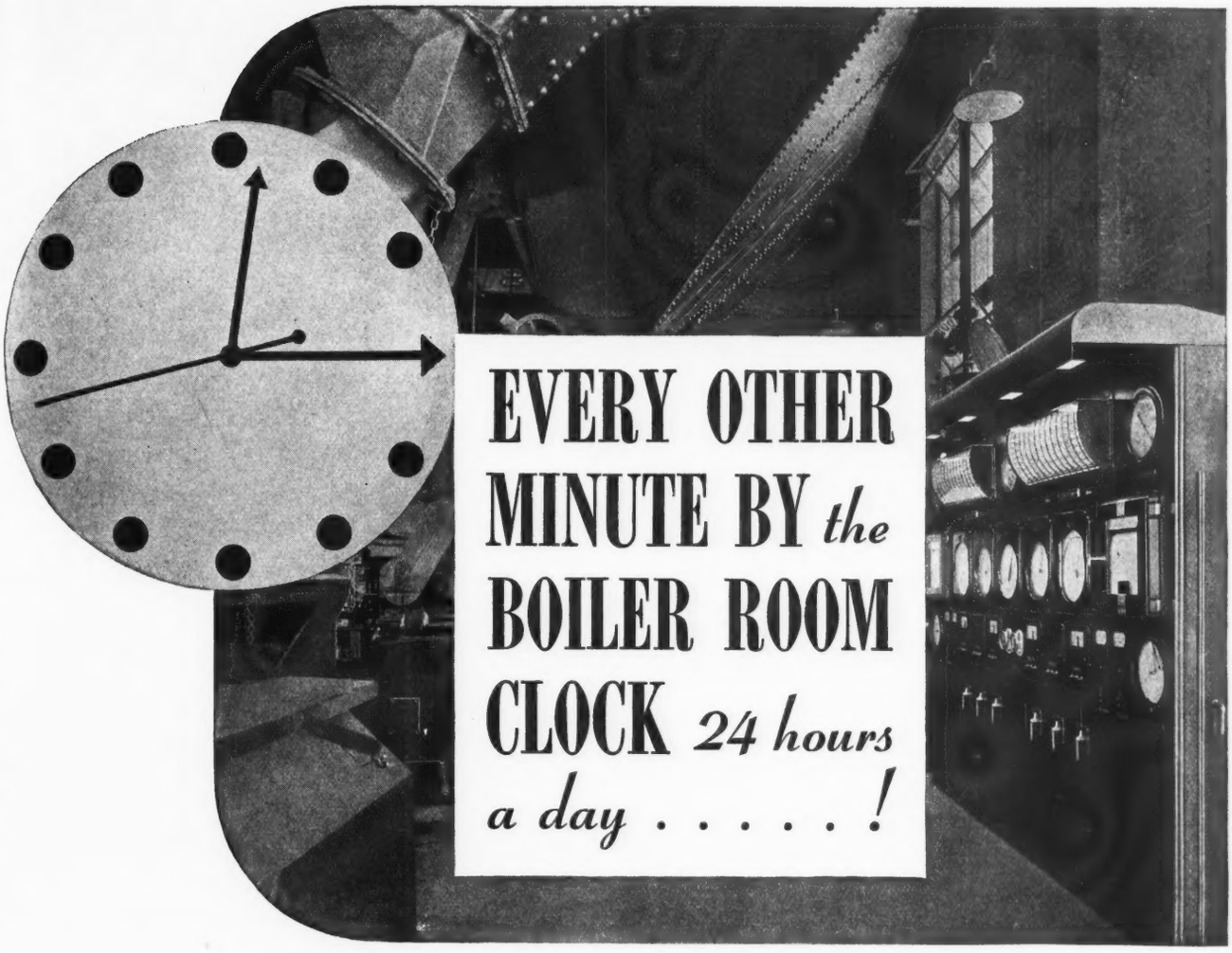
Made-Rite Plugs are merely slipped into the end of a leaky boiler tube and pulled up tight with any ordinary wrench—they hold tight indefinitely—can be used over and over again and pay for themselves with the *first* leak.

Available for fire and water tube boilers and condensers in all tube sizes.

Immediate shipment. Guaranteed to STOP LEAKS. Write at once for prices and details.

**Hardie Made-Rite Boiler Tube Plug Co.**

1245 Madison Ave. New York, N. Y.



# EVERY OTHER MINUTE BY *the* BOILER ROOM CLOCK *24 hours a day . . . . . !*

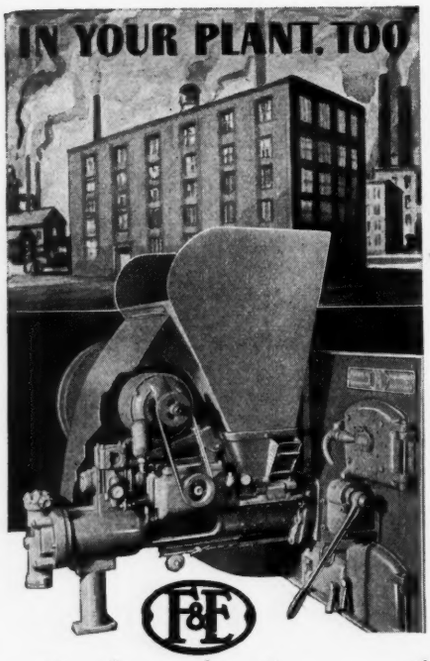
THIRTY times an hour—720 times every day the Hays Combustion meter analyzes your flue gas for $CO_2$ content and records the results for every man to see. There is no guesswork, no room left for excuses. Month after month the results are recorded as they happen.

In leading power plants from coast to coast Hays Combustion recording and control equipment is keeping every day's performance at peak efficiency, eliminating waste, ruling out guesswork.

If you are not familiar with this outstanding line of equipment, with its superior performance and its money saving efficiency, let us send you complete catalogs and information by return mail. There is no obligation. Write to 905 Eighth Avenue, Michigan City, Ind.

The HAYS CORPORATION

SINCE 1901 — COMBUSTION INSTRUMENTS AND CONTROL — MICHIGAN CITY, INDIANA, U.S.A




*Hydraulic Powered*

**UNDERFEED STOKERS**

*will give*

"above-the-ordinary" performance

In every field of industry, "F & E" is acclaimed for the dependability, economy and efficiency produced by the "F & E" Five-Feature Combination—an achievement in stoker design. In no other stoker will be found this combination of desirable stoker features:

**1**—"F & E" Electro-Hydraulic Drive, operated by a constant speed motor, is the simplest stoker drive yet developed. It is a compact, self-contained unit, containing only five moving parts, all enclosed, operating in a bath of oil. There are no pipes, fittings, gears nor ratchets to wear out or break.

**2**—The patented Interval Timer Governor—provides an unlimited number of coal-feeding rates—assures Full-Stroke, Full-Speed Ram Action at all times.

**3**—The "F & E" Sliding Bottom Retort,

**4**—The "F & E" Fuel Bed Regulator and

**5**—"F & E" High Efficiency Tuyeres—combine to produce perfect fuel delivery and highly efficient combustion.

If your present fuel-burning equipment is not giving you dependability, efficiency and economy—investigate "F & E." Send today for literature that will show you how the "F & E" stoker, backed by a company nearly 100 years old having hundreds of outstanding installations, will solve your fuel-burning problems.

F&E *Hydraulic Powered*

The "F & E" ANTHRACITE STOKER (another "F & E" product) is fully approved by the ANTHRACITE INDUSTRIES LABORATORY. Literature will be sent upon request

**UNDERFEED STOKERS**

*are manufactured by*

**FLYNN & EMRICH CO.**

ESTABLISHED 1842

Baltimore, Maryland


St. Marys contracted Westinghouse Electric & Mfg Co, for turbine-generator and auxiliaries for municipal electric plant, where improvements will be carried out. Also made award to Condenser Service & Engineering Co for condenser and accessory equipment; and to General Electric Co for switchboard. Cost about $90,000.

**OKLAHOMA**——Perry contracted Fulton Iron Works, St. Louis, for engine unit and other equipment for municipal electric plant, where expansion and improvements will be made. Cost about $82,000. V V Long & Co, Colcord Bldg, Oklahoma City, consulting engineers.

Bethlehem Supply Co, National Bank of Tulsa Bldg, Tulsa, manufacturer of oil-well equipment and supplies, plans extensions in recently acquired local plants of International Supply Co, and Oklahoma Iron Works, Inc. Cost over $500,000 with machinery and power equipment. G A Thompson, vice-president and general manager.

**OREGON**——Columbia River Packers' Assn, Astoria, plans addition to cold storage and refrigerating plant at Hawthorne, with installation of additional equipment. Also will make extensions and improvements in cannery at Elmore, and expansion in cold storage facilities at other points. Entire project will cost about $150,000.

**PENNSYLVANIA** —— Textile Machine Works, Inc. Reading, plans 1-story addition to textile machinery plant, and will begin work soon. Cost about $100,000 with general machinery and power equipment.

**SOUTH CAROLINA**——State Sinking Fund Commission, Capitol Bldg, Columbia, plans central-heating plant in new 5-story State office building on local site. Cost close to $800,000. Lafaye & Lafaye, and H M Fair, 1226 Sumter St, architects.

**TENNESSEE**——TVA, Knoxville, contracted Sterling Engine Co, Buffalo, N. Y., at $13,217 for one 425-hp gasoline engine-generator unit and accessories.

Citizens Ice Co, Covington, plans 1-story cold storage and refrigerating plant, with about 300 locker units. Cost close to $40,000, with equipment.

**TEXAS**——Crosbyton contracted Fairbanks, Morse & Co for equipment for diesel engine-generator unit and other equipment for municipal electric power plant, including electrical distribution system, at $97,225. Municipal Engrg & Finance Co, Mercantile Bldg, Dallas, consulting engineer.

Robstown contracted Eugene Ashe Electric Co, Bankers' Mortgage Bldg, Houston, at $246,330 for municipal electric power plant, including diesel-generator units and accessory equipment. Garrett Engrg Co, Houston, consulting engineer.

Texarkana plans municipal electric plant. Cost about $545,000, of which approximately $300,000 has been secured through Federal aid.

Sabinal plans pipeline system for municipal natural-gas distribution, including main welded-steel pipeline for connection with supply source, control station, etc. A bond issue of $35,000 has been authorized. Proposed to begin work soon.

Board of City Commissioners, Galveston, plans new booster pumping stations for municipal water system, with installation of motor-driven pumping machinery to increase capacity by about 2,000,000 gpd. Cost close to $75,000. Proposed to ask bids soon. Freese & Nichols, Capps Bldg, Fort Worth, consulting engineers.

Baird contracted Fairbanks, Morse & Co, at $145,122 for diesel-generator units and auxiliary equipment for new municipal electric power plant.

**WASHINGTON**——Lewis County Public Utility District No. 1, Chehalis, plans early purchase of two or three high-speed diesel-generator units, from 45 to 60-hp rating, with complete auxiliary equipment, to be used for standby service at Randle and Alpha.

Bureau of Yards and Docks, Navy Dept, will award contract soon for new boiler plant at Puget Sound Navy Yard, Bremerton. Cost about $150,000.

**WISCONSIN**——Board of Rock County Commissioners, Janesville, is considering extensions in power house at institution near city, including installation of new boiler unit and auxiliary equipment. Bradley & Bradley, 226 South Main St, Rockford, Ill., architects.

Nunn-Bush Shoe Co, 2822 N Fifth St, Milwaukee, has begun construction of a new power house at factory, 50 x 90 ft, to cost about $50,000, with equipment, to include boiler units, stokers, pumps and auxiliaries. Oscar A Kisa, 2932 N Newhall St, consulting engineer.

**THE TWO REASONS**

why "AMBEST" Packing should be found in all well appointed engine rooms are:

- **To take care of emergencies,**
  ***And the other***
  **for permanent service.**

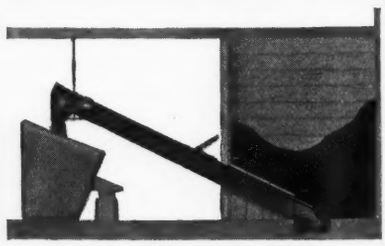
*Manufactured by*

**EUREKA PACKING COMPANY**

294-296 46th Street Brooklyn, N. Y.

**A few selected territories still available for salesmen acquainted with the supply trade.**

**FILL STOKER HOPPERS** *automatically*



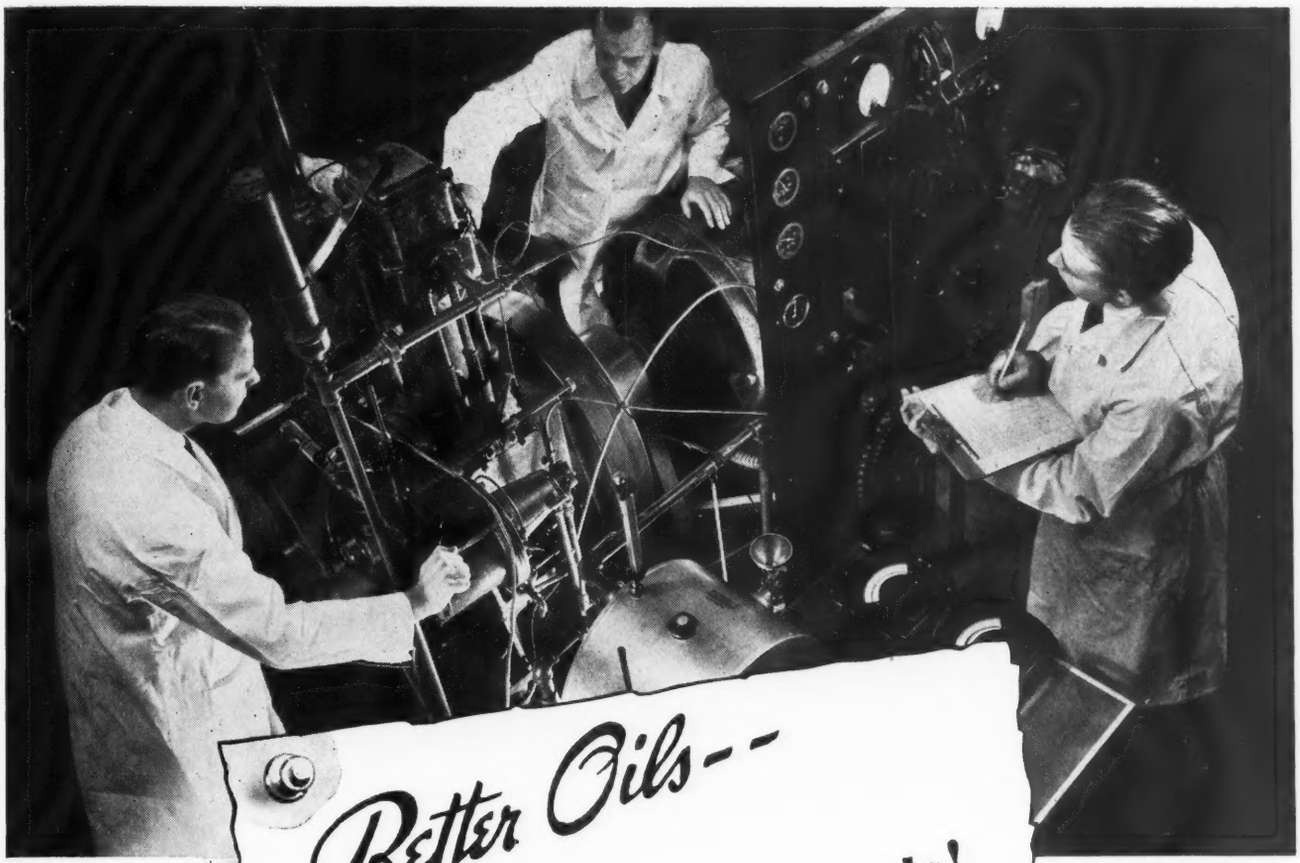
**A labor-saving device that is easy to install and can be adjusted to fit practically any condition or any stoker hopper. Distance from coal pile only governs length of the loader . . . capacity up to 10 tons of coal per hour . . . simple and safe to operate . . . nothing to maintain . . . right or left-hand operation . . . suspended from ceiling or supported by stand from floor . . . equipped standard with 1½ H.P. motor. Write for complete details.**

**D. J. MURRAY MFG. CO.**

*Wausau, Wisconsin*

*Established 1883*

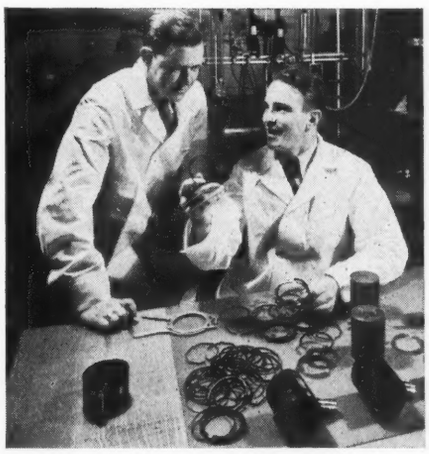
**MURRAY-NADEAU** *STOKER LOADER*




# GULF RESEARCH TECHNICIANS develop improved lubricants . . . help industry reduce operating costs!

PICTURED above is a typical scene in the Gulf research laboratories. Gulf technologists, in this instance, are working with an experimental Diesel engine, studying Diesel lubrication problems. Nearby, another exhaustive research goes forward on the lubrication of a modern type of textile spindle. In the next room a railroad car bearing is being run under precisely the speed and load conditions of actual service. And a host of other lubrication problems —many of them born of our rapidly advancing mechanical age—are being studied each day by Gulf's large staff of scientific men.

To what end is this extensive research work carried on? What is its objective? By perfecting better lubricants, and better methods of applying them, Gulf is doing its part to *help industry reduce operating costs*—save money on maintenance and power, improve production and make the machinery for which you paid real money last longer.

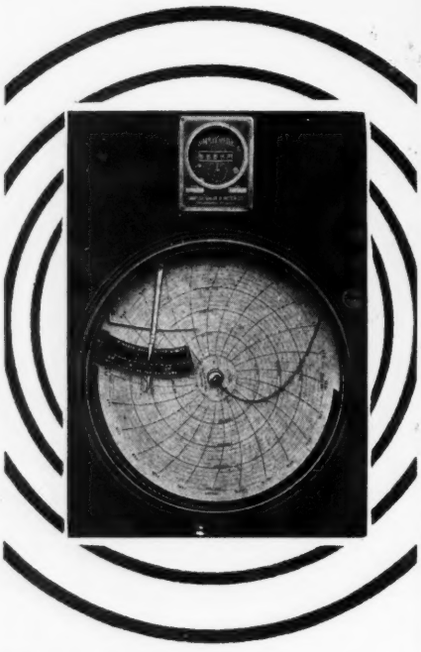


*These Gulf technologists are examining pistons and rings removed from the experimental Diesel engine shown above, after an extended period of operation. They find that ring sticking, cylinder wear, ring wear, gum formation and objectionable deposits have been minimized by the proper use of the right grades of Gulf's higher quality Diesel lubricants.*

Your machinery, old or new, will be better prepared to give you the efficient production you need when you protect it with Gulf's higher quality oils and greases. Available to you, through more than 1100 warehouses in 28 states, is Gulf's complete line of 400 quality oils and greases . . . and the services of an experienced Gulf lubrication engineer. Ask him to recommend proper lubrication for your equipment. GULF OIL CORPORATION, GULF REFINING COMPANY, PITTSBURGH, PA.

GULF INDUSTRIAL LUBRICATION

# SIMPLEX
## FLOW METERS



# Let's Look at the Record

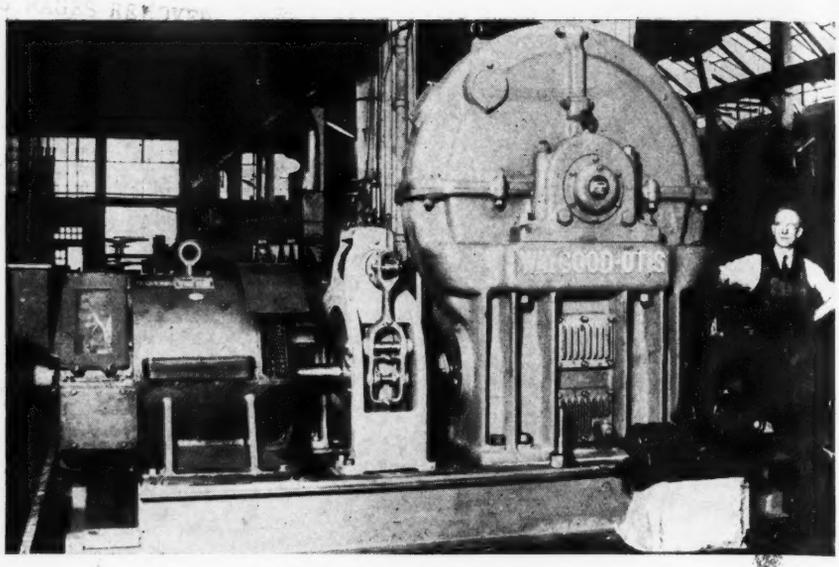
The minute-by-minute story of plant requirements and boiler room out-put is always right before your eyes when Simplex Flow Meters are on the job.

They are unusually accurate, sensitive and wide-ranged.

Designed to indicate, record or totalize the flow, or any combination of these functions.

For complete data on these money-saving instruments write us today for Bulletin 52.

SIMPLEX
VALVE & METER CO.
6780 UPLAND ST., PHILADELPHIA, PA.

**ESCALATORS GO HIGHER**

Escalators, originally designed for low lifts of one or two floors, have gradually developed into real elevators. Two Otis units in the Lexington Ave and 53rd St station of the Independent Subway, New York, N. Y., top all installations in the U. S. with a vertical lift of 56 ft. The subway system in London, England, however, goes this one better—18 Waygood-Otis escalators serve vertical rises of 58 to 81 ft in six stations, and operate at a maximum speed of 180 fpm. They have a full load capacity of 16,000 persons per hr. One of the machines required to operate these escalators is shown

## The Reason Lube Oil Doesn't Wear Out

WHY *is it that lubrication oil properly taken care of will last almost indefinitely? Is it true that reclaimed oil may be better than the original when new?* WDJ

*This question was submitted to Prof James I Clower, Virginia Poly Institute, who gave this answer—Editor.*]

ALL MINERAL oils are made up of two substances or elements—carbon and hydrogen. These two elements are united or combined chemically to form hydrocarbons. It happens that these two elements will combine chemically in different ratios. That is, say, one pound of carbon might combine with one pound of hydrogen in one instance, and, in another, two pounds of carbon might combine with one pound of hydrogen. This combining ratio depends chiefly on the conditions under which the two elements are brought together. For example, if they are combined at a low temperature, the combining ratio would be different than if they were brought together at a high temperature.

Now let us consider a particle of carbon and indicate it by the letter *C*. This particle is capable of uniting with 4 particles of hydrogen under the most favorable conditions. Under less favorable conditions, the particle of carbon might combine with 3 or even less particles of hydrogen. If we think of a carbon particles having four hands and each hydrogen particle containing only one hand, then it will require 4 particles of the hydrogen to grasp the 4 carbon hands.

If hydrogen and carbon combine in such a ratio that all hands of the carbon particles are grasped by the hydrogen hands, the hydrocarbon is said to be *saturated* because there are no free carbon or hydrogen hands. On the other hand, if there are only three hydrogen hands that grasp the carbon hands, there will be a free carbon hand. A hydrocarbon so formed is called an unsaturated hydrocarbon, and has a hand which is free to grasp a particle of some other substance, such as oxygen. Under certain conditions an unsaturated hydrocarbon will readily grasp a particle of oxygen and becomes oxidized.

Now when a hydrocarbon is oxidized, it becomes a sticky, gummy-like substance. This is what is meant when an oil is said to have broken down. Oxidized hydrocarbons are not good lubricants, not only because they are sticky but also because they are mildly acidic. The saturated hydrocarbons do not readily change in this manner. Dust, water and other impediments may and usually do get mixed with them, but they remain the same; just as impurities may get into water. But we know that if the impurities are removed from water that it is still water and as good as ever. So it is with oil that is not oxidized.

All oils are mixtures of saturated and unsaturated hydrocarbons. The more highly refined the oil the fewer are the unsaturated hydrocarbons and the greater are the number of saturated hydrocarbons, and the less is the tendency for the oil to oxidize. In a sense, we can say that the unsaturated hydrocarbons of an oil do wear out, but all of the oil does not. Now if we remove the oxidized hydrocarbons (broken-down ones) and the foreign impurities from a used oil, we will have nothing but the saturated hydrocarbon (the strongest and best) portion remaining. This is why some contend that reclaimed used oil is better than new oil. If reclaiming is efficiently done, they have a good case.